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TELEVISION BROADCASTING

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Production, Economics, Technique

BY

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WITH A FOREWORD BY

DAVID SARNOFF

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To those scientists, engineers, and laboratory workers who have created a new social force that fulfills man's age-old desire to see beyond his horizon, this book is dedicated

PREFACE

On Apr. 30, 1939, regular public television service in the United States was inaugurated in New York City by the Radio Corporation of America, through the National Broadcasting Company. As these pages go to press, it is still too early to judge with accuracy the degree of public acceptance that the new art enjoys. Its final values, its ultimate effect as a force in our daily lives, will become clearer as the art develops. But there can be no doubt that a great new service has been opened to mankind, destined perhaps to become the greatest social force the world has yet known. And, remarkably enough, in this country this milestone has been reached practically without public or governmental financing. Its research and development expenses have been borne by those organizations which have brought television to its present stage.

Television is a vastly complicated device—in the opihion of those competent to judge, a hundredfold as complex as our familiar broadcasts of sound—and its development requires consummate personal skill as well as engineering genius. The minds of many men have labored on the problems, each confined to a special field of endeavor. They have been true pioneers, advancing into fields not explored by man before.

In each new industry, the name of one man stands preeminent. Not often is it given to one man to stand twice in that position. But to Mr. David Sarnoff goes that honor. Years ahead of its actuality, Mr. Sarnoff outlined for his superiors the aural broadcasting service of today. In television, it has been he who has made possible, to the American public, television as a regular service. Over the years, as its president, he has directed the work of RCA, coordinating the efforts of its associated companies as each group toiled on its phase of television, and from his courage and inspiration have emerged a second new art and a new industry.

Television, or as a more descriptive term, "radiovision," has not been launched without a very thorough apprenticeship in the laboratory and in the studio. Field trials of the entire

system were under way for several years prior to the beginning of public service, and the planning and research have extended back over 10 years.

The fruit of these years of preparation is the "capital" of the new art. During this time, a technically practical television system has been devised. Technicians have been trained to operate it on a regular schedule. Program techniques have been modified—and new ones invented outright—to meet the demands of the system's capabilities. Performers and directors are learning to coordinate their productions with split-second smoothness and accuracy. The output of the system was offered through field tests to a small but typical audience of "lookers-in" whose reactions have been painstakingly tabulated and analyzed. Finally, the whole problem of supporting the service without direct cost to the public has been the subject of constant research.

This far-reaching preparation for a new public service is rarely paralleled in the history of American enterprise. In every comparable case, including the closely related instances of motion pictures and sound broadcasting, the initial offerings to the public were pleasing by novelty rather than performance comparable to older forms of entertainment. The first television to the public was on a plane of performance, relative to the problems involved, not approached by the initial stages of any other basic invention. The fact still remains that the problems of television are difficult ones and the degree of achievement represented by the system must be correspondingly great, if nationwide public acceptance is to be assured.

It is with this background of the new art in mind that this book has been written. Its purpose is, first, to review the "capital structure" of the television art, as it is revealed in the experience of NBC and in the researches of its parent company RCA. These organizations have been fortunate in having at their command the personnel and resources necessary to carry forward actively every phase of television development, from its inception to the present.

The second purpose is to emphasize the need for coordination in television as a public service. Those who have the responsibility of developing the service are only too well aware of the magnitude of the problem and of the very high degree of coopera-

tion necessary between all branches of the art. In radio engineering, in the theater, and in the arena of the amusement world generally, as well as in the advertising profession, coordination is essential if the highest degree of effectiveness is to be achieved in the television service. It is hoped that this book may clarify the part that all these factors can play in developing the new art and industry on solid foundations.

During the technical development period of television experimentation, the research and development work of the RCA companies were coordinated by a Television Committee, of Messrs. V. K. Zworykin and E. W. Engstrom of the RCA Manufacturing Company, C. H. Taylor of RCA Communications, Inc., O. B. Hanson, C. W. Horn, and C. W. Farrier of NBC, and C. B. Jolliffe of RCA, with Mr. Ralph R. Beal, Director of research for RCA, as chairman. Since the advent of regular programing, this committee has continued to function, and Mr. Frank E. Mullen, vice-president of RCA in charge of advertising and publicity, has been named to coordinate the efforts of the companies in nontechnical activities. Within NBC, Mr. O. B. Hanson, vice-president in charge of Engineering, directs the engineering operations of television and Mr. Alfred H. Morton has been made vice-president in charge of television. Under Mr. Morton's direction, with Mr. Max Gordon, world-famous Broadway producer, as counselor, a television staff is being built up which is demonstrating its ability to grapple with the complex and often unknown television problems confronting NBC. The company is striving for a close union with the older, more experienced groups whose business is entertainment, in the firm belief that their interests and those of television have a basis in common.

For convenience, the book is divided into two sections. The first deals with television in relation to the public, that is, the programing of a television service. The second part deals more with the internal relationships in a television broadcasting system, including the economics of the plant and production departments, the legal background, and a review of the technical features of the system that have important bearings on the present capabilities of the art.

The author is indebted to those who have contributed their knowledge and time to the compilation of this report. Special acknowledgment is due to Mr. Ralph R. Beal, research director of

RCA, for his assistance and constructive suggestions, and to Mr. Donald G. Fink, managing editor of *Electronics*, and to Miss Martha S. McGrew and Mr. N. E. Kersta of NBC, for their assistance in editing and revising the manuscript. Others to whom cordial thanks are due are Messrs. Frank E. Mullen and Horton H. Heath of RCA, Dr. Alfred N. Goldsmith, consulting engineer to RCA and former vice-president of that company; Messrs. H. C. Bonfig, Thomas F. Joyce, and T. A. Smith of RCAM; Messrs. Charles H. Taylor and Nils Lindenblad of RCAC; Messrs. O. B. Hanson, A. H. Morton, F. E. Mason, C. W. Farrier, C. T. Morgan, George McElrath, C. W. Horn, T. H. Hutchinson, R. M. Morris, R. E. Shelby, J. A. McDonald, L. H. Titterton, E. A. Hungerford, Jr., F. A. Wankel, R. F. Guy, C. A. Rackey, G. W. Payne, Leif Eid, Henry F. Ladner, and Don Glassman of NBC.

LENOX R. LOHR.

NEW YORK CITY,
March, 1940.

CONTENTS

FOREWORD

Mr. Lenox R. Lohr, president of the National Broadcasting Company and the author of this book, is ably qualified to appraise the problems and the possibilities inherent in the field of public service that television has now entered. For the past several years, while research engineers were bringing television out of the laboratory and through tests in the field, Mr. Lohr and his able associates have studied and experimented unceasingly in the important realm of television program development. It has been—and is—their problem to adapt the artistic and informative potentialities of this new medium to the many technical factors involved and to accommodate both art and technique to economic realities. Mr. Lohr's book presents an interesting picture of this unique and fascinating problem and will live, I believe, as a valuable historical record of the status of television during its first year of public service in America.

The advent of television climaxes an amazing century of scientific progress. Of the whole series of modern inventions that have revolutionized the material aspects of civilization, this new art is perhaps the most miraculous. The collaboration of brilliant minds; the integration of many discoveries in the field of electronics; the patient, repeated testing of new principles and devices until a practical answer was evolved represent the engineering background of a great achievement of industrial science.

And yet, although after many years television has arrived, it is only at its beginning.

Television, I believe, is destined to provide greater knowledge to larger numbers of people, truer perception of the meaning of current events, more accurate appraisal of men in public life, and broader understanding of the needs and aspirations of our fellow human beings.

It also marks a beginning, I trust, of greater appreciation of the gifts of music and musicians, of art and artists, of drama and actors, and more opportunities for laughter and social companionship.

It brings a beginning, I hope, of a deeper sense of spiritual values, a keener appraisal of truth, a higher development of the individual, and a wider devotion to the ideals of the free people of the earth.

We have learned to believe in the miracles of science. Television is such a miracle. But television, if it is to fulfill its highest purpose, must begin where science leaves off and help bring about new miracles, not only in machines but also in men—miracles to which the human heart as well as the human mind must contribute.

DAVID SARNOFF.

NEW YORK CITY,
March, 1940.

TELEVISION BROADCASTING

CHAPTER I

TELEVISION AND SOCIETY

The extent to which electrical systems of communication have affected modern society is so great that there is hardly a person in the civilized countries of the world whose life is not directly influenced by them every day. This fact is well appreciated. What is not so clearly recognized is that modern communications systems are, in point of fact, very definitely limited in the class of information and entertainment that they can transmit. The telegraphic forms of communication, by wire and radio, are restricted to the use of symbols, which must generally be translated and retranslated before the message is delivered. The telephonic forms, the telephone and radio broadcasting, are much more comprehensive than the telegraphic, but here the information is limited to that which may be perceived by the sense of hearing divorced from the sense of sight. This division of two senses that we are accustomed to use together has required considerable ingenuity on the part of the sound broadcasters to evolve a satisfactory program technique that depends on the hearers' imagination to paint the scene and to visualize the appearance of the performers.

With the coming of television, this restriction is removed. The simultaneous transmission of sight impressions with the associated sound impressions constitutes true communication in its broadest sense, for sight and hearing together constitute the most fundamental avenue of communication to the human mind. Either sense by itself is insufficient, as those afflicted with deafness or blindness testify. But together they bring to us virtually our entire knowledge of the world.

There are, of course, other means of communication that involve both the eyes and the ears. The sound motion picture is a conspicuous example, and it maintains a popularity that fully illustrates the effectiveness of an appeal made to the emotions and the intellect by visual as well as auditory means. But there is a definite difference between the appeal of motion pictures and the appeal of a television program.

The key word of television's unique appeal is *spontaneity*. The fact that it is possible to bring events into the home while they happen, without delay, with no extraneous interpretation or editing lends a quality to television that no other means affords. Sound broadcasting comes close to the ideal, since it affords descriptions of events as they occur. But in sound broadcasting, the listener must depend on the acuity and the discretion of the narrator; what the listener hears is the narrator's interpretation. In television, each member of the audience can see for himself what is going on, and he can form his own impressions. True, the services of an expert television narrator are desirable in supplementing the viewer's knowledge and in guiding his eyes to the regions of greatest interest in the scene. But the final judge of what goes on is the viewer himself. The narrator is a partner, not an interpreter.

To those unfamiliar with television programs, the importance of spontaneity may seem out of proportion to the simple wonder of being able to see through space. But this wonder is soon dispelled as the viewer becomes used to the new medium. Thereafter the question becomes a very simple one: What can television give me that some other means of entertainment or instruction cannot give? In the answer to this question lies the true significance of television as a social force.

At first glance, it might appear that television is useful because it can supply all the well-known forms of entertainment in a very convenient manner directly in the homes of the audience. The television camera can transmit a conventional sound movie, for example, with excellent clarity. To many it is much more pleasant to enjoy this sort of entertainment in the comfort of an easy chair than to go to the neighborhood theater. But this is by no means a universal reaction. A great many people, including members of the present television audience who have been questioned on this point, greatly prefer to go to the movie

theater because it offers an opportunity to "get out of the house and mix with other people." It is true that television can provide the conventional forms of entertainment, and it is true that present program schedules include much of this type of material. But the unique value of the television system lies in its ability to provide entertainment and instruction that its audience could not otherwise have.

Take a prize fight, for example. In the nature of things, no more than a few hundred people can be seated in the ringside seats where the full action of the fight may be viewed in detail. The space of one or two ringside seats devoted to a television camera is capable of giving the same firsthand view to thousands of viewers *who would not otherwise have the opportunity under any conceivable circumstances.* The transmission of news events as they occur lies in the same category. The occasion may be one of great significance, or it may be commonplace. But the fact that the viewer of the television scene feels himself to be on the scene, watching each turn of events as it occurs, lends an enchantment that no other medium of communication can give.

So simple a thing as a Memorial Day parade has been shown capable of holding a television audience solidly for three hours. Part of this interest can be accounted for by the fact that nearly everyone likes to attend a parade and that it is especially convenient to be able to do so in one's living room. But a much more fundamental reason is the fact that at all times the audience had the impression of spontaneity and immediacy. In the ordinary course of events, a parade is marked by few incidents; but the audience feels certain that if anything unusual does happen, they will see it and can form their own judgment of the occurrence immediately.

The second advantage of a television service, beyond transmitting events as they occur without interpretation or editing, is the one of bringing the best talent to the greatest number of people economically. This particular advantage has been put to the fullest use in sound broadcasting, but the possibilities of the sight-plus-sound-plus-immediacy formula add another dimension to it.

While it appears likely that, as in sound broadcasting, the entertainment aspect will constitute the major appeal, the possibilities in education are especially attractive. True enough,

television can never supply the vital give-and-take relationship between student and teacher, nor can it impose the discipline that is so necessary a part of school life. But as a tool to supplement the individual teacher, television has a place in the school that transcends the present high value of sound radio as a teaching aid.

At the present writing, with public television service in its first months, many experiments in educational techniques have been proved thoroughly worth while. Geography has been made interesting by such explorers as Sir Hubert Wilkins who while present in the studio have exhibited their films to their colleagues seated around a discussion table. The television camera looked in on the proceedings, bringing with it the whole viewing audience. The technique of measuring the minute electrical potentials created by the thought processes in the brain has been successfully demonstrated, and indicates that the possibilities are limited only by the resources and imagination of the broadcaster.

Many of the uses of a television system had been visualized long before the technical means of accomplishing them were forthcoming. In fact, attempts to transmit visual information by wire are as old as the telephone itself. The fact that the telephone was developed successfully nearly 50 years before television became practical is simply testimony to the fact that hearing is a simple process, whereas seeing is a very complicated one. Telephony has advanced to the point of substantial perfection where modern high-fidelity reproductions of speech and music can hardly be distinguished from the original. Since television is the newest member of the electrical-communication family, it can make no such claim to perfection. But television today, in its first offerings to the public, has capabilities that no other system of communication can claim. When its present restrictions are removed, as they eventually will be, even conservative opinion admits that television is destined to become one of the great forces of the civilized world. Even before it reaches its ultimate perfection, it seems certain to be one of the most effective means of mass entertainment and education which modern science has developed.

This much is generally admitted. But there are other implications in the new art not so readily grasped. Television has all

the potentials of a great advertising medium, perhaps the most effective ever devised. When these potentials are realized, television will become a great seller of goods, and its effect on industry generally will then have a most far-reaching effect on our national life. By stimulating consumer needs, television may multiply our rates of production and consumption beyond all our present conceptions.

FIG. 1.—Television demonstration of the use of modern business machines, broadcast from outside the studio.

Realizing the potentialities of the new medium, advertisers and their agencies, representatives of competing mediums, and observers with an eye to possible social effects are studying the uses, techniques, and probable results of advertising by television. These men agree that television can show goods and demonstrate their qualities adequately in the home. Several programs designed to show the merchandising capabilities of the system (but offering no goods for sale) have been produced and analyzed by competent advertising experts and by lay members of the audience. From these preliminary studies, it appears certain

that television is an effective medium for selling goods. The chief question remaining is to build up the "circulation" of the medium to the point where the costs can be borne by advertisers.

Economists have already given the motion picture its due as a stimulant to trade. American movies have sold goods everywhere, because movie audiences, the world over, have learned of the existence of useful commodities by the simple process of seeing them as a part of the world on the screen. In similar but even more effective fashion, television can demonstrate the existence and utility of goods in the home, where the visualization of the goods in use can be made most effectively. In a word, television can spread to its audience the knowledge of the utility of commodities.

Mention has been made of the economic advantage of bringing the best talent to great numbers of people at low cost. The same principle applies in the merchandising of goods. When the most talented salesmen can be projected into thousands of homes with active assistance in the form of actual demonstration, the prospect, if a product is salable at all, can be sold under these circumstances.

It seems likely that the advent of advertising in television will mark a return to the older method of merchandising—the personal approach by the salesman, showing the product he has to sell and demonstrating its merits. The images of the product on the screen are retained in the memory longer than the names by which they must be remembered in sound radio. With such visual images firmly implanted in the consumer's mind, it is possible for him to make a purchase simply by pointing to the package on the store shelf.

The projection of the salesman into the home, it must be remembered, can be made to occur on a very high plane of consumer acceptance by proper balance between merchandising effort and the entertainment offered by the sponsor. The facts that the viewer of a television program must perforce give the program his entire attention and that he listens and looks of his own free will add to the effectiveness of the medium.

Experimental commercial programs, involving no payment for facilities on the part of the sponsor, have been televised since the beginning of public service on Apr. 30, 1939. As for the future, two conditions must exist before television broadcasting

can be commercial in the same sense as is sound broadcasting today. (1) It is necessary for the public to be using a sufficient number of receivers to justify advertisers in making sufficiently large expenditures for programs and technical facilities. (2) It remains also for the Federal Communications Commission to sanction outright commercialization as in the case of sound broadcasting today.

Although it requires no great gift of prophecy to predict in general terms the future of television, the character of the ulti-

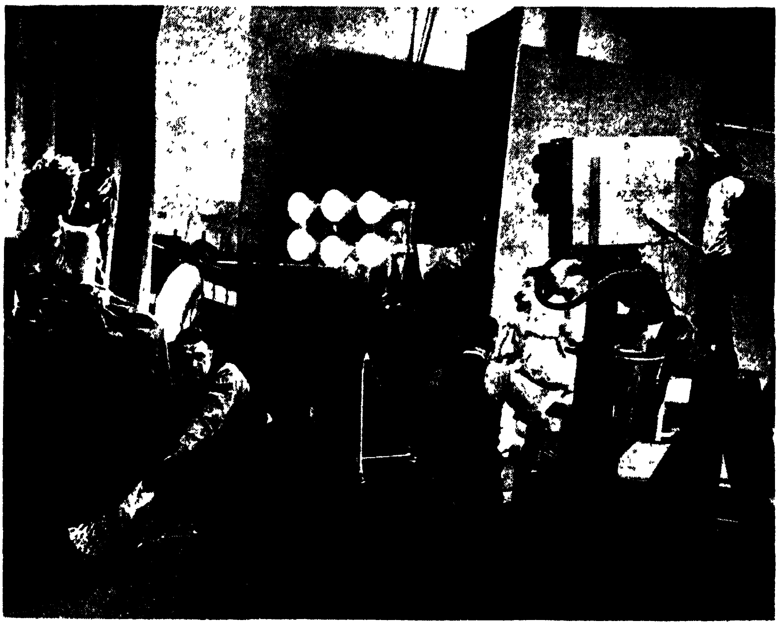


FIG. 2.—Televising a hair style and fashion program.

mate program service has not yet fallen into definite molds. "For good or for ill," said the National Resources Committee in a recent report on television to the President of the United States, "a new day is dawning in entertainment, and eventually will dawn in school education. Technology has provided the power to enrich the leisure hours, to promote family solidarity by bringing the theatre into the home, to develop national uniformity and unity at the cost of provincialism, and to widen man's knowledge of the world in which he lives."

The National Resources Committee envisaged "a great scientist performing experiments as he talked about them to the children, an artist drawing, and explaining why he drew as he did, a musician, statesman, inventor, capitalist or handicraftsman demonstrating his work." Again, television may "telescope into a few seconds, millions of years of geologic time, make the movements of gases and electricity visible, present explosions without doing damage, gather the four corners of the world, with their living, singing people, into each classroom, and make the past live again in the present, in moving dramas of history."

The television staff of the National Broadcasting Company has been engaged for more than four years in research and experiment concerning program material for television. Whatever the character of future television program schedules, there is not the slightest doubt that the new art will convey impressions of modern life with a vividness and accuracy comparable to any agency hitherto devised. Drama gains by intimacy; news, by affording first-hand observation; entertainment, by spontaneity.

New callings are being created as television swings into its stride. To gather and present material over television, photographers and films are required; new performers with qualifications differing from those needed in sound broadcasting; men skilled in the technique of blending film, still pictures, and live talent into a single continuous performance; directors to draw from all the arts and entertainment fields and to adapt them to television needs. Men abreast of the day's affairs must plan the excursions of mobile television stations mounted on trucks to scenes of important or interesting happenings. Eventually there must be new studio plants, perhaps built on the movie-"lot" principle, where programs may be produced over many hours of a day.

The radio-set manufacturer, naturally, has a major stake in the development of television. It is his job to provide the means for building "circulation" for television. If he meets these demands adroitly, television will progress rapidly; if receivers perform unsatisfactorily and cost too much, the march of television will be retarded. There are now on the market simple sound and sight receivers, and combination television and all-wave radio sets. In the future, we may see combination phonograph, facsimile, television, and all-wave receivers, built in one cabinet.

The development of the television-receiver industry will have its effect on the life of the nation just as surely as does the program service itself. The industry offers a new consumer product of wide potential distribution. As the demand for television sets increases, the demand for parts and tubes increases in proportion. More than this, since the technical problems associated with development are considerably more complex than those of sound radio, the industry affords new outlets for trained technicians and engineers, both in numbers and in difficulty of their work.

An important contribution of the radio manufacturer to the progress of television is the television kit for the amateur. Already several construction kits of this type have found their way to the market. These kits include not only wiring diagrams but also printed step-by-step instructions, so that not only radio amateurs but anyone interested in home workshop activities can build a receiver.

The investor has been and will continue to be offered ample opportunity to participate in the development of television. He has received considerable attention for more than a decade. The possibilities of television are so alluring that it is easy to build up enthusiasm. But the necessity for close investigation of any stock proposition cannot be urged too strongly; unsupported enthusiasm always has been a poor guide to investment.

What the industry needs is the type of pioneering investment which is necessary to the development of any new art and industry and which, if it be soundly administered, promises future profits commensurate with the risks involved. In so far as the public desires to participate in such a program, and in so far as the situation is made clear to the investor, investment should be encouraged, but not otherwise. Actually, by far the greater part of the present investment in television development (estimated to be between $10,000,000 and $20,000,000 at present) has been made from the working capital of companies who have a substantial stake in the radio industry.

The coming of television not only introduces the broadcaster to many attractive opportunities and possibilities, but it also brings to him a great many new problems in the fields of studio construction, film projection, scenic design, costuming, performing talent, studio lighting. It brings him face to face with a whole new set of technicians—carpenters, scene painters,

designers, costume experts, wardrobe mistresses, make-up men, historical-research specialists, lecturers, actors, camera operators, film editors, directors, and assistant directors.

As television progresses, much of this responsibility in programing will be borne by network companies. For television, if it is to fulfill even a small part of its promise, must be predicated on a network operation similar to sound broadcasting. If television's program service is to be of the first order, syndication is highly desirable.

The need for network television broadcasting or other means of syndication arises partly in the economic advantage that is inherent in offering a given program to the largest possible audience. But the social significance is equally great. Sight-and-sound programs offered to the whole country at once must necessarily operate to reduce the differences between people, both economic and political, that are based on geographical separation. Middle Westerners, enabled to look with their own eyes on the night life of New York, will find it very little different from the local pastimes. Nor is such appreciation a one-way affair. City dwellers, looking in on the network circuits working in reverse from the less populated areas, will gain a new insight into the quality and substance of rural life. Television caters to curiosity, and it answers curiosity with facts. Such an agency, operating on a national scale, cannot avoid producing a better understanding between the people of different sections and consequently a more unified nation.

At the time of this writing, the first indications of a television network are in the form of negotiations between the General Electric Company and the NBC. The plan is to pick up by radio in Schenectady programs emanating from the NBC transmitter atop the Empire State Building in New York City, for rebroadcast from the General Electric Company's transmitter on Helderberg Mountain in the Schenectady-Albany area. Also, definite steps are being taken on a similar direct radio hookup with a transmitter in the Philadelphia area.

What the future will bring in networks no one can be sure, but it does appear that the first television networks will stem from the present installations in New York City; that later, others will center about Chicago, and that still others will have their key stations located in the large cities. Finally—and

speaking in terms of years—these will all be joined together in a national network such as is currently common in American sound broadcasting.

There are at present four important possibilities with respect to television networks, that is, the syndication of programs from a central point. Performing troupes may be transported bodily from one station to another to afford "live-talent" programs. The material televised by one station may be photographed and passed on to others, and standard films may be circulated. Stations linked by radio relay systems are the third possibility. Another is the network created by the use of coaxial cable. The final solution may well be a combination of two or more of these methods, the ultimate objective being to create television networks that will provide a satisfactory television signal in every part of the country. When this objective is reached, the disadvantage that the rural and semirural populations suffer in regard to educational facilities, art museums, and sporting events will be lessened.

Before the cessation of service in England, due to the war situation, the British Broadcasting Corporation had been broadcasting television programs regularly for two years. The service had been for three hours daily, on a single station, and reliable reception was limited to the London area. Technically, the BBC system was essentially the same as that employed in America. The BBC television project, however, derived its financial sustenance from a license fee levied on every house that had a radio receiver.

During the period immediately preceding the European difficulties in September of 1939, Germany, through its Post Office Department, announced the beginning of a public television service, which has not yet eventuated. This operation also was to be financed by license fees on sound-radio receivers. Ambitious plans were reported for a small network by means of radio relays and cable, though no attempt was indicated to carry television to every section of the country.

The French Ministère des Postes, Télégraphes et Téléphones had completed a new transmitter prior to September, 1939, in the Eiffel Tower in Paris, over which experimental programs were being broadcast. With the advent of hostilities, these were discontinued.

In the United States, no government subsidy for television is available, nor has any such support ever been seriously considered. American television broadcasting will develop along the lines followed in building the American system of sound broadcasting. NBC, for example, will devote a major portion of its program schedules to noncommercial programs, produced and transmitted at its own expense. A portion of the time on the air will be sold to advertisers. with the usual safeguards for the interests of the consumer.

There are more radio stations in the United States offering a wider variety of programs on which much more money is spent than in any other country in the world. The competition between advertisers and between the broadcasting networks has ensured that the programs conform to the public taste, and the public has responded by installing more radio receivers per capita than in any other country. Competition has an equally great effect on improving the technical standards of operation of broadcast stations. This is the record of sound broadcasting. There is no strong reason to believe that the record of television will differ materially. Competition, on a noncommercial basis, which will be afforded as soon as more than one station in a locality begins to broadcast regularly, will be welcome stimulus to the television broadcasters.

In summary, we may inquire what is to be gained socially and otherwise by the three participating groups in the television field: the public, the industry itself composed of television broadcasters and equipment manufacturers, and the advertisers. The public has three important stakes in the new art. First, there is the entertainment made available. Second, when commercialization of programs begins, viewers will have a new means of judging the desirability of advertised products. In time, it is quite possible that the owner of a television receiver will depend upon it as a catalogue of consumer goods and as a means of observing products in use before buying them. And, of course, there is the educational value as the third advantage.

The television industry is at present coincidental with the radio industry, so the benefits to be derived by the industry from the television system must be examined in the light of television's effect on radio. The writer is undisturbed over the likelihood of any immediate effect on the sound-broadcasting business. In the

long run, it is logical that sound-broadcasting stations will adopt television simply as a better means of carrying on their business. But the transition will be slow, and sound broadcasting will have full opportunity to make whatever adjustments to television are necessary. The immediate benefits for the industry involve new products to sell, *i.e.*, furnishing new facilities to advertisers and consumers alike. A not-to-be-overlooked benefit to the industry is the good will gained by establishing a new public service and devoting working capital to the development of a definite contribution to society.

The advertiser's stake in television is more remote at present but nevertheless real. Television is a new and highly effective medium, offering all manner of opportunity for program techniques and for the development of consumer reaction to the end that more goods shall be sold.

Eventually, equilibrium will establish itself along the following lines: The viewing public will exchange the price of a television receiver as well as its attention and good will for the entertainment and education of the programs and for information on the products advertised. The broadcaster will exchange the consumer's good will for the support of his station by advertisers. Finally, the advertiser will use the consumer good will to continue or to increase the sale of the products which he has advertised.

It must be emphasized, however, that this state of affairs cannot be established overnight. In developing television in America, the broadcasters must operate for several years at least, with considerable losses. Profitable television will have to wait upon "circulation"—thousands of receivers must be scattered among viewers before the broadcaster can hope to sell enough time on the air to regain even his out-of-pocket expenses. The cost of receiving sets is a factor of high importance in the promotion of mass circulation. High initial expense of home receivers would deter mass acceptance of television Popular prices, coupled with technical and program excellence, will bring about mass acceptance. The public, unreasonably perhaps, expects television to be born in full bloom, with the elaborate production methods of moving pictures and the precision of sound broadcasting. This involves a programing expense many times higher than any income possibilities; but anything less postpones

further the day of a public acceptance sufficient to warrant the buying of time on the part of advertisers.

One thing is certain: If the broadcasters do not give the viewer what he wants, then they will have failed. And if they fail, then some agency other than the broadcasters will take over the development of the new art. In any case, television is inevitable.

This book, based on NBC's operating experience with the RCA television system, is submitted in the hope that what we have learned and the judgments that we have so far made may be helpful in advancing the progress of this new contribution to our civilization. Television is a rapidly developing art. Many of the impossibilities of yesterday are the realities of today. As the field of use of the new art expands, we may expect constant improvement.

CHAPTER II

THE TELEVISION SYSTEM

Television, as indicated by the Greek and Latin words from which the term is derived, means seeing at a distance. A fuller definition, which applies to the system now in use, is: Television is the instantaneous transmission of moving images containing sufficient detail for entertainment or for informative purposes, the whole being accomplished by electronic means. It is in this latter sense that the word is now commonly used.

The idea behind television is anything but new. Men for hundreds of years have had the desire to see what was going on just beyond their horizon, an urge now expressed as the need "to go places and see things." But practical television has a very recent origin. The development of workable devices lies almost exclusively in the twentieth century, although the roots of television extend back into the nineteenth.

Before television could come within the realm of practical devices, certain fundamental discoveries had to be made, chief among them the unearthing of materials capable of transferring light energy into electrical energy. The first such material discovered was selenium, isolated by Berzelius in 1817. Berzelius, however, knew nothing of photoelectricity, and it was not until 56 years later, in 1873, that the photosensitive quality of selenium was observed by a telegraph operator named May. Working in a cable station at Valentia, in southwest Ireland, May noticed that the selenium resistances that he was using behaved erratically when exposed to sunlight. Observation soon led him to the discovery that the metallic element's resistance to the flow of electricity decreased as the intensity of light falling on its surface increased.

This discovery focused the attention of scientists on the possibility of converting light values into electrical values under controlled conditions. And if that were true, it followed that an image of a scene or picture might be converted into its electrical equivalent and transmitted by wire over considerable distances.

During the next decade and a half, numerous schemes were advanced. G. R. Carey, an American, in 1875 proposed to imitate the human eye. His plan was to construct a mosaic composed of minute selenium cells upon which a light image could be projected. The light image would create in the cells minute electric currents which, in turn, would operate individual shutters placed before a bank of lights, thus reproducing a crude image in black and white squares.

Ayrton and Perry advanced a similar scheme in 1880, although they probably conceived their idea several years before that time. The method involved was complex, but the idea advanced by these pioneers (converting the illumination of each selenium cell into electric currents and then transmitting each impulse separately to the receiver) was basically sound. It was obvious, however, that the number of electrical circuits required for the transmission of even a moderately detailed image would be tremendous. According to present standards, some 200,000 circuits would be required for the transmission of a picture of sufficient detail to afford entertainment possibilities. Some other line of research had to be evolved before the problem could be solved practically.

The new idea took the form of "scanning" the picture. Maurice Leblanc, a French investigator, laid down the fundamental principle of scanning in 1880, when he stated that the way to send a picture was to break the scene up into elemental areas of light and shade, transmit these separately in a definite order, and then reassemble the elemental areas at the receiver in the same sequence. Leblanc's method of accomplishing this process involved the use of mirrors, one to oscillate at high speed in one plane for the scanning of each individual line, and another, at a lower speed in another plane, for shifting the scanning line downward. Sawyer, Senlacq, and others also advanced proposals for scanning systems.

The best known and simplest method of scanning was that patented in Germany by Paul Nipkow in 1884. Nipkow's device was simply a flat, circular disk, in which a series of holes were punched near the outer edge, in the form of a spiral. When rotated before the eye, the disk's outermost hole afforded a view of a strip across the top of the subject to be scanned. The second hole permitted a view of the strip immediately under and adja-

cent to the first; and so on, until the entire subject was scanned in a series of lines. In effect, Nipkow's system was to convert the entire image into one long strip of various lights and shadows. These, in turn, were to be converted into electrical impulses of varying intensities by a selenium cell behind the disk.

At the receiver, the process was to be reversed. A light source, modulated according to the strength of the successive impulses, was to distribute the lights and shadows in their correct sequence on a screen by means of another scanning disk. The whole operation was to occur at such high speed that an observer would get the impression of a composite and continuous picture. The disk in the receiver, of course, had to be whirled in exact time with that at the transmitter. Otherwise, what was at the bottom of the original image might appear at the top in the reproduction.

Five years later, L. Weiller devised a system of scanning in which the place of the Nipkow disk was taken by a rotating drum on which a number of mirrors were tilted at different angles. As the drum rotated, the image was scanned in a series of lines and projected on to a selenium cell for the conversion of light into electricity.

In its subsequent development, television adhered to the basic idea of scanning as laid down by Nipkow and his contemporaries. The disk has gone through many refinements, such as the addition of more and smaller holes and fitting the holes with lenses; but it held its leadership among scanning systems until it encountered the rivalry of electronic methods in the late 1920's. What impeded television development after Nipkow's time was the lack of sensitive and rapidly acting devices for registering light changes and the lack of reliable devices for amplifying the feeble electrical impulses generated in the light-sensitive cell.

The next important step in television was marked by the introduction of the cathode-ray idea. Karl Braun, at the turn of the century, brought forward a crude device that was the forerunner of the modern television picture-reproducing tube. Braun's tube was an evacuated funnel-shaped glass structure at the narrow end of which a source of free electrons (tiny particles of negative electricity) was situated. These electrons were sprayed, like water from a hose, on a chemical substance, coated on the inside of the other end of the tube. This substance was found to glow under the impact of the electrons, that is, to create a

spot of light where the electrons hit the coating. Braun demonstrated that a magnetic field, created by a coil placed about the neck of the tube, would sharpen the spot of light created in the fluorescent material at the "open" end of the funnel-shaped tube and that the stream of electrons that produced the light could be moved about by the same means. If the motion of the beam could be made to follow a definite pattern, and if it could be so varied as to register various degrees of light, then a picture could be traced on the fluorescent screen.

Boris Rosing, a Russian physicist, in 1907 patented a system in which the Braun tube was the central feature of the receiver. His transmitter, however, still followed in the tradition of mechanical scanning. Two mirror drums, rotating at right angles to each other, were to scan the subject. The one, rotating at high speed, was to effect the horizontal scanning; the other, revolving at a much lower rate, was designed for shifting the scanning line. Reflections of light from the televised subject were to be registered by a photoelectric cell. The variable impulses generated thereby in the cell were to control the intensity of the cathode-ray beam that scanned the fluorescent screen. Rosing's idea marked a milestone in television thought, but his success in demonstrating his equipment was never complete. The lack of sensitive and reliable equipment, particularly some means of amplification, still held back the progress of the new art.

The idea of television without the aid of a single moving mechanical part, surprisingly enough, came close on the heels of Rosing's patent. Advanced in a rough form in 1908 and elaborated in an address before the Roentgen Society in 1911, a television system in which cathode-ray tubes of suitable design were to be used at both transmitter and receiver was outlined by A. A. Campbell-Swinton. Although his approach was purely theoretical, Campbell-Swinton hit on most of the essentials of today's electronic television system. A few years later, the World War intervened, and television research was sharply curtailed.

When workers in the field again took up the task of perfecting television in the early 1920's, they had improved materials. Dr. Lee de Forest's audion, the three-element vacuum tube invented in 1906, had undergone a period of very rapid improve-

ment during the war. Around this tube were built efficient amplifiers. Improvements had been likewise made in the photoelectric cell, and research had discovered far more responsive photosensitive elements than selenium.

C. F. Jenkins, a veteran American inventor, and John L. Baird, the Scot, stood out among a large number of experimenters. Both were concerned with the development of mechanical scanning. Both gave demonstrations in 1925 of "shadowgraphs," crude images in black and white. Baird, in January of the following year, successfully demonstrated television with various gradations in light (half tones) before members of the Royal Institution at London. He later transmitted an image by radio from England to the United States.

The success of Baird and Jenkins and a remarkable demonstration given by engineers of the Bell Laboratories in 1927, when they transmitted both an image and its associated sound from Washington to New York, gave rise to confident predictions that television was imminent as a public service. Dr. E. F. W. Alexanderson headed a staff of engineers at the General Electric Company laboratories which gave several notable demonstrations of television at Schenectady, including one in which a large image was projected on a movie screen.

In 1929, the status of television was as follows: Mechanical scanning (rotating disk or drum) was employed. The images, as seen in the receiver, were very small and extremely crude. The picture definition, measured by the division of the image into scanned lines, was not more than 60 lines. The pickup-camera apparatus was fixed; the subject had to be brought to it. The transmission of a person's head and shoulders strained the resources of the scanner and transmitter. Obviously, a program service given within such technical limitations could have little entertainment value.

Continued research resulted in increasing the number of scanning lines to about 180 per picture, to be followed by 240-line images, all transmitted by mechanical methods. The increased detail in the images forced higher and higher speed in the mechanical parts, until the majority of the investigators despaired of presenting an image of fine detail by mechanical scanning.

Nevertheless, public interest was aroused over the prospect of pictures through the air. Several television stations were built

and operated on an experimental basis. Among them was station W2XBS. This station was built in 1928 and operated by the Radio Corporation of America at two different locations in New York. Later, it was operated by the National Broadcasting Company and then moved to the Empire State tower in 1931, where its present transmitter is located.

Noteworthy is the fact that at this time men began to realize that much more was involved in television than a knowledge of

FIG. 3a.—Comparison between 60-line mechanical scanning on the left and modern 441-line scanning on the right. See Fig. 3b opposite.

electricity. Basic research had to be made in optics, electronics, physics, chemistry, and many other branches of science. Specialists in various lines were drawn into the laboratory to solve the problems that continually presented themselves.

In the United States, notable developments in television have issued from the various laboratories of RCA. The entry of this company into the field occurred in 1928 before the introduction of the electronic system of television. In 1930, RCA enlarged its laboratory staff by the addition of several distinguished investigators engaged in television research. Among these men was Vladimir K. Zworykin, a Russian-born scientist and a former student of Boris Rosing at the Petrograd Institute of Technology. Dr. Zworykin had already taken out his first patent on what was to be the basis of the all-electronic system of television.

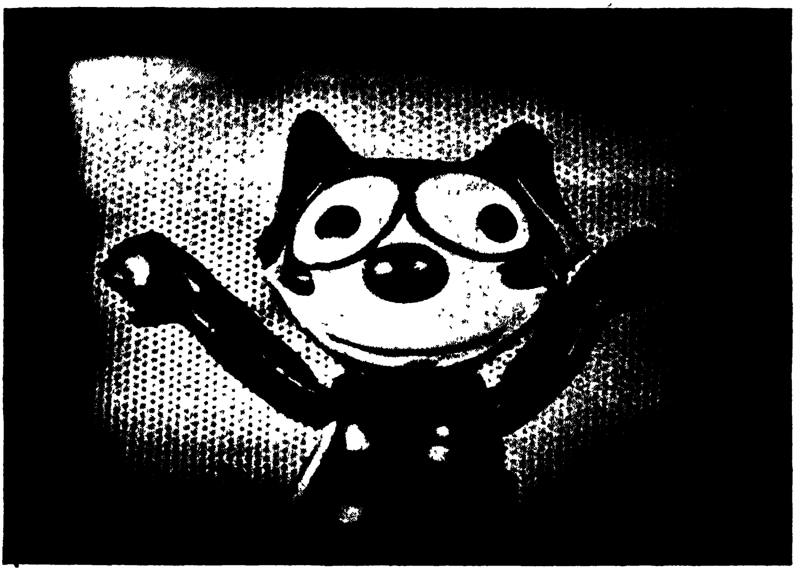


FIG. 3b.—In the modern picture the tiny dots visible are on the acoustic wall material, in the studio. They further indicate the definition possible with 441-line scanning.

The patent was granted in 1923 on a system for the "cell storage of light." A year later he actually demonstrated a crude sort of tube to be used in televising a scene without recourse to mechanical scanning.

In 1929, while in the employ of the Westinghouse Company, Dr. Zworykin had demonstrated a transmitter based on mechanical scanning with a receiver in which the Kinescope, or improved form of Braun's cathode-ray tube, was the instrument for repro-

ducing the transmitted image. This system, which transmitted 120-line pictures, was shown at a meeting of the Institute of Radio Engineers at Rochester, N. Y. Four more years elapsed, however, before Dr. Zworykin announced a workable television-camera tube, the Iconoscope, which supplanted the mechanical whirling disk and answered the need for a television system without moving mechanical parts.

Dr. Zworykin has since gone on to improve the nonmechanical system of television. A projection tube, anticipating the demand for television images thrown on a screen, was demonstrated by Drs. Zworykin and R. R. Law in 1931 and in 1937 at a meeting of the Institute of Radio Engineers in New York. This device, too bulky for home use, cast an image 8 by 10 ft. in size.

The television staff of NBC has been associated with the members of the RCA television group and has operated the television station on an experimental basis since 1930. NBC has provided the proving ground for all the devices created in the RCA laboratories. Test broadcasts have been conducted at intervals by the NBC engineers over a period of 9 years.

After several years of experimental broadcasting with mechanical scanning apparatus, the two companies built an entirely new transmitter at the Empire State Building and simultaneously equipped studios at the Radio City headquarters of NBC for broad experimentation in all phases of television broadcasting.

The completed apparatus of station W2XBS underwent a severe test period during the summer of 1936 before NBC gave its first demonstration for members of the press in November, 1936. The transmitted images were scanned in 343 lines at the rate of 30 complete pictures a second. In January of the following year, however, definition was raised to 441 lines (in accordance with the proposed standards of the Radio Manufacturer's Association), a figure at which it has since remained.

Substantial contributions to the art were made by other workers during the same period (1929–1938). In America, one of the outstanding pioneers is Philo T. Farnsworth, who developed a television-camera tube known as the "image dissector." Farnsworth and his associates have also been active in the design of circuits associated with the cathode-ray tube.

In 1936, the Columbia Broadcasting System, which had previously experimented with mechanical television, undertook to install an all-electronic system and purchased a television transmitter from the RCA Manufacturing Company. This transmitter has been installed in the tower of the Chrysler Building, in New York City, with studios in the Grand Central Terminal Building, near by. This installation was scheduled to go into operation with a public television service some time in the late months of 1939.

The Don Lee System has operated a television station in Los Angeles for several years. This is an electronic system and operated on local standards until June, 1939, when it was converted to the RMA standards. The Zenith Television Corporation began regular program service in Chicago early in 1940. This also operates on the electronic system and RMA standards. Television transmitters have been in operation from time to time in Philadelphia, Schenectady, Passaic, Boston, Kansas City, Iowa City, Camden, Albany, and Bridgeport, but none of these had established a program service for the public at the time of writing. Several other broadcasters over the country are studying television possibilities in their own communities and have already purchased demonstration equipment.

Before describing the electronic system of television, it is desirable to make clear some of the physical bases on which television rests.

All television depends on a peculiarity of the human eye known as "persistence of vision." The impression of any scene persists in the mind of the observer for a fraction of a second after the scene is removed. Hence it is possible to present to the eye, in rapid succession, many separate scenes without the observer's being aware of the individuality of the scenes themselves. Slight differences between the successive scenes can then be made to appear as continuous motion. This is the principle upon which motion pictures, as well as television, depend. The effect may be readily demonstrated by whirling a glowing piece of punk in the dark. The path taken by the glowing ember appears to leave a continuous trail of light, but this is purely an illusion which arises from the persistence of vision.

The human eye sees by means of many tiny cones and rods in the retina. Each rod and cone is sensitive to light and conveys

an impression of the illumination impressed upon it to the brain, over the fibers of the optic nerve. It is not necessary to excite all the cones and rods simultaneously in order that the brain may receive a picture. Instead, during the fraction of a second in which vision persists, a complete image is assembled line by line before the eye, which thereby sees the picture "all at once."

The televised subject is scanned, in the present electronic system, into the equivalent of about 200,000 picture elements. The

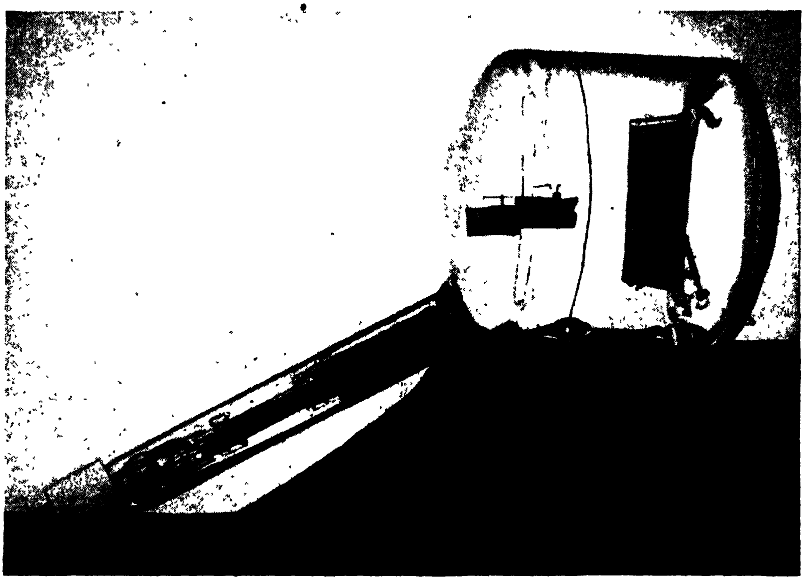


FIG. 4.—An Iconoscope of the type used in television cameras during 1938.

electrical impulses representing these 200,000 elements are transmitted, in definite scanning sequence, in slightly less than one-thirtieth of a second, which is well within the time permitted by persistence of vision. In all, 30 complete pictures are sent in a second, and the illusion of motion is thereby transmitted.

The Iconoscope is the instrument that views the scene to be televised and dissects it into its elemental areas. The essential parts of the Iconoscope (see Fig. 5) are (1) a light-sensitive plate inclosed in the "drum" end of the tube and (2) an "electron gun" in the tube's neck. The plate, measuring 3⅝ by 4¾ in., is covered with hundreds of thousands of very small

photosensitive particles, each insulated from the others. When a scene before the camera is focused on this plate, each of the tiny particles develops a charge in proportion to the amount of light falling upon it. In this way, the scene of lights and shadows is converted into a corresponding electron image with varying intensities. These charges cling to the cells until they are neutralized by the scanning process.

The electron gun, the second essential of the Iconoscope, fires a beam of electrons, which are in themselves particles of negative electricity, in the direction of the light-sensitive plate. The electrons, arising initially as an unorganized cloud, are focused into a beam finer than the head of a pin. The beam is then made

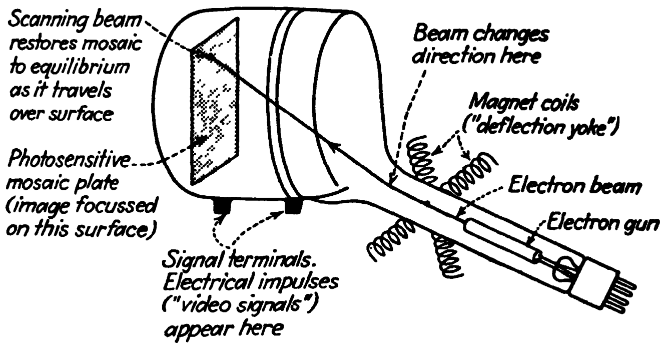


FIG. 5.—The essential parts of an Iconoscope.

to describe a pattern of some 400 horizontal lines by means of magnetic fields created by coils encircling the neck of the tube. The exact number of lines, from the beginning of one picture to the beginning of the next, is 441. However, approximately 40 of these lines are not active in reproducing the picture, since they occur in the brief interval between pictures. The pattern followed is the same as that followed by the human eye in reading the print on the page of a book. It proceeds from left to right and from top to bottom.

When the beam touches one of the small particles of photosensitve material, it restores the natural equilibrium of the particle and in so doing creates a minute electric current. This impulse varies in intensity according to the charge stored up in the individual particle, so that once the beam has swept over the entire plate it has given rise to enough electrical impulses to

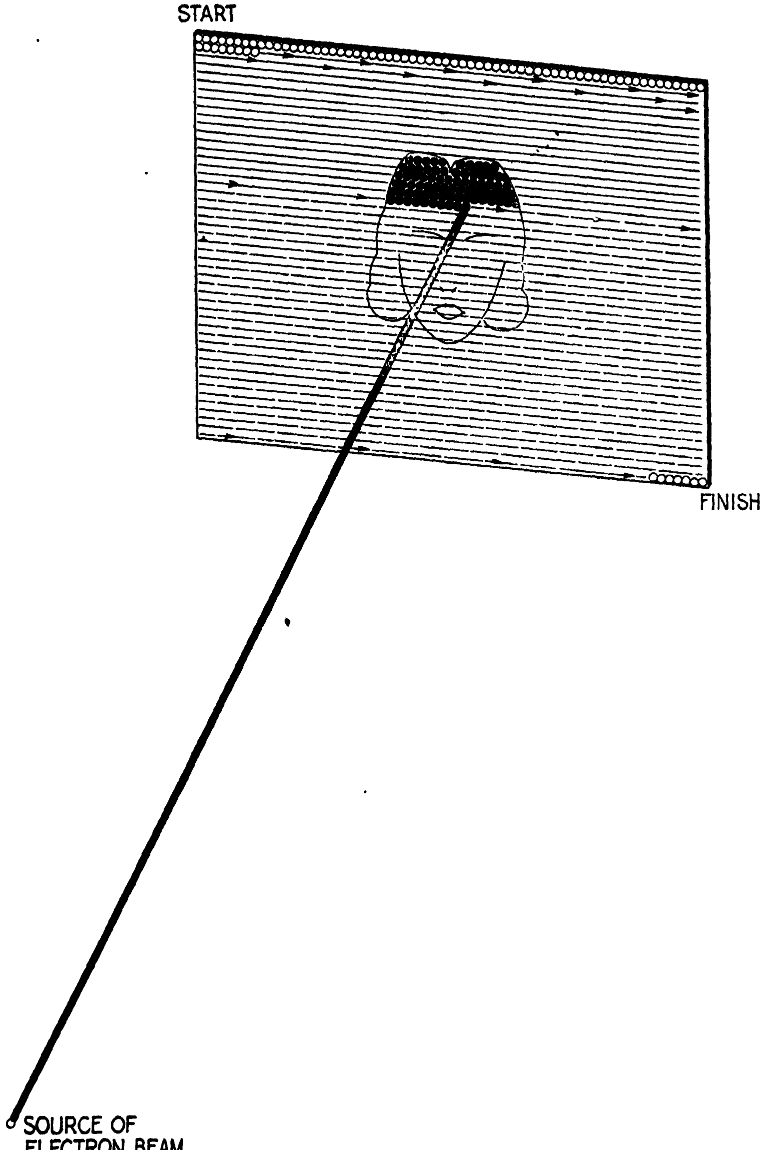


Fig. 6.—Process of scanning: Picture is analyzed point by point in a definite sequence, the amount of light associated with each point registering a corresponding influence on the transmitted radio signal. At the receiver, the process is virtually reversed.

represent the entire image focused upon it. These are taken off the Iconoscope circuit, strengthened, and then passed further to the television-transmission system.

An examination of each scanned line in the reproduced image reveals that its shading varies from left to right. These variations reproduce the half tones that are present in the corresponding line of the image of the scene transmitted from the studio. The function of the television system is to transfer these half tones from studio to receiver and to preserve their proper locations in the area of the scene.

Here we come to the basic advantage of an electronic scanning system over the earlier mechanical methods. In order to scan 30 detailed pictures in 400-odd lines within a second's time, the beam must cover some 6,000,000 separate elemental picture areas within that time. In so doing, the beam must move at a velocity that would be impractical, if not impossible, for a mechanical system to attain. This constitutes part of the reasoning why the earlier systems failed to achieve the fine detail possible with the modern electronic system.

The impulses generated by the television camera are very feeble as they leave the Iconoscope. They must be strengthened, or amplified, many thousands of times before they can be transmitted. To safeguard the "video signal" (the picture impulses) against loss, interference, and distortion, elaborate precautions are taken. In particular, it is necessary to employ amplifiers capable of amplifying without discrimination alternating currents whose frequencies range from 30 to 5,000,000 cycles per second. Thus preserved and amplified, the video signal is passed on to a transmitter where it is launched on a radio-carrier wave, exactly as in the case of sound broadcasting.

Set free in space, the carrier signal radiates in all directions. Upon being intercepted by a suitable antenna connected to a television receiver, the signal passes through amplifier circuits and at length reaches the "screen" of the Kinescope, or reproducing tube. In a general way, the operation of the television receiver corresponds to the way a sound-broadcasting wave is amplified before it actuates the loud-speaker which converts the inaudible signal into audible sound. In the case of television, the invisible electrical impulses are converted by the Kinescope into a visible image.

The Kinescope, which reverses the process of the Iconoscope, is a vacuum tube containing an electron gun that fires a beam of electrons at a translucent screen at the other end of the tube. This screen consists of a fluorescent material which glows when

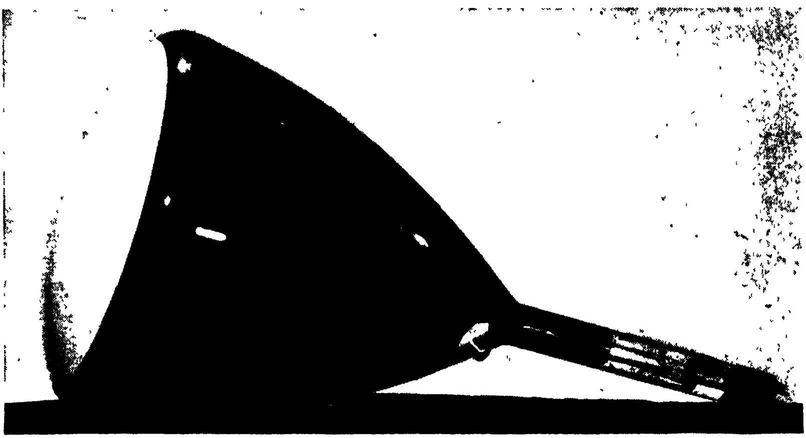


FIG. 7.—A type of Kinescope used in a television receiver of 1939.

it is bombarded by the electron beam. The light that it emits depends on the intensity of the electron beam. As in the case of the Iconoscope, the electron beam scans from left to right and from top to bottom. The video signal, after being amplified in the receiver, varies the intensity of the Kinescope's electron beam.

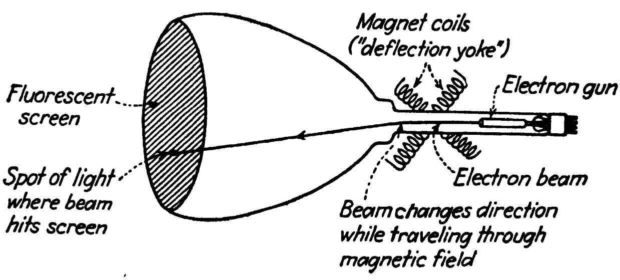


FIG. 8.—The principal parts of a Kinescope.

In this way, the beam is made to "paint" a graphic image of varying shades as it sweeps over the fluorescent screen.

The two beams, one in the Iconoscope and the other in the Kinescope, begin scanning at the same instant, and the light variations picked up by the Iconoscope beam are produced exactly

by the Kinescope beam, line upon line, until a complete likeness of the original scene is reproduced on the Kinescope screen. In this description of "picture painting" on a Kinescope screen, no area larger than the head of a pin is illuminated at any one instant. Only the persistence of fluorescence in the screen material and the persistence of vision in the human eye create the illusion of a complete image.

During the entire transmission, the scanning of the electron beams in the Iconoscope and the Kinescope must be perfectly timed. The synchronizing of the two beams is brought about by a series of impulses originating in a synchronizing generator and transmitted with the video signal. The generation and transmission of synchronizing impulses require such precision that a deviation as little as 1/5,000,000 sec. interferes with the fidelity of the reproduction.

The sounds accompanying the scene are transmitted on an ultra high-frequency channel adjacent to the video channel by means of the conventional microphone, transmitter, and receiver. Synchronization between sight and sound is completely automatic, since both picture-transmitting and sound-transmitting systems function practically instantaneously. The term "television system" is now defined to include the functions of transmitting the sound as well as the associated picture.

The foregoing description of the picture-reproducing tube (Kinescope) shows that the size of the reproduced picture is definitely limited by the area of the fluorescent screen at the end of the tube. At present, tubes providing pictures larger than approximately 8 by 10 in. are not available to the home. Larger picture tubes than this can be built but only at great expense, since the glass of which they are made must be capable of withstanding the external air pressure, which amounts to several tons on a large tube and increases directly with the surface area of the tube.

Is not the limitation of picture size to 8 by 10 in. a serious limitation to effectiveness of the television system? It may suffice to say that the principal question to be answered in considering picture size is the ratio of the height of the picture to the distance at which it is viewed. For most observers, the preferable value of this ratio is roughly one to five. That is, most observers prefer to view a picture at a distance five times as

great as the picture is high. This ratio is the one that obtains, for instance, in the center seats of the average motion-picture theater.

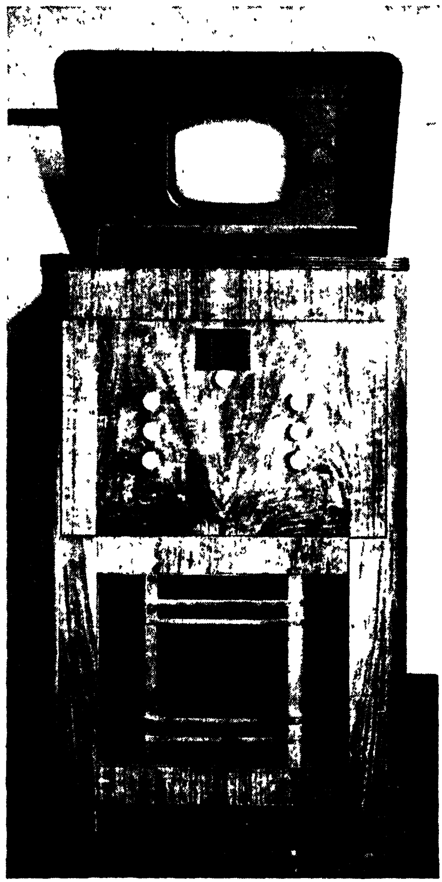


Fig. 9a.—A model of receiver used during the field-test period of the development of the RCA-NBC television system.

Modern high-fidelity television pictures contain sufficient detail to permit this 5:1 ratio to be used with nearly optimum visibility of the picture detail. Thus, if a picture 8 in. high is viewed from a distance of $8 \times 5 = 40$ in., the 5:1 ratio obtains, and at the same time the eye assimilates substantially all the detail present in the picture. A viewing distance of 40 in. is

not too close for viewing in a living room when the audience consists of only 3 or 4 people grouped around the receiver. For larger gatherings, however, a longer viewing distance is desirable. For example, in a living room 20 ft. long, accommodating an audience of say 10 people, it is quite conceivable that the desirable viewing distance would be 10 ft., and the picture in that event should be 2 ft. high. At present, no direct-viewing picture-reproducing tube is available for producing a picture of this size.

The problem of picture size also arises when it is desired to exhibit television pictures to theater audiences. This aspect of television development is an exceedingly important one for the

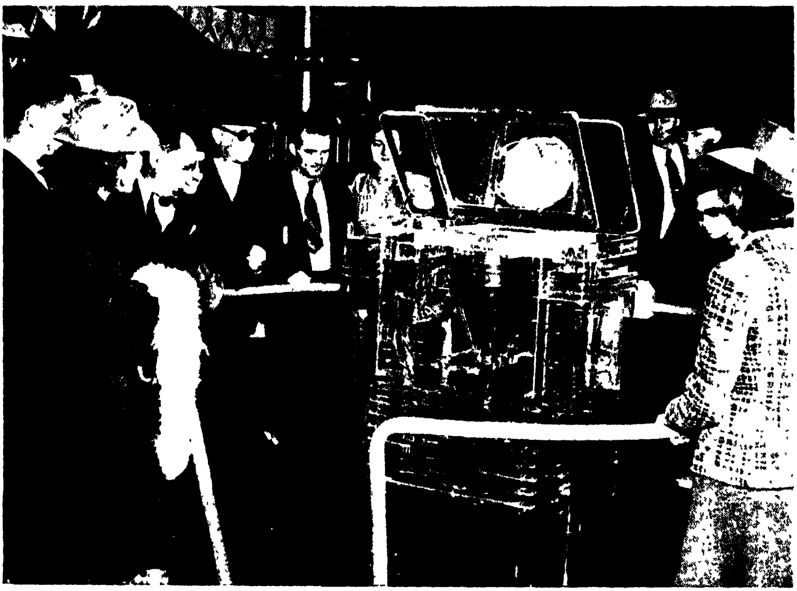


FIG. 9b.—An all glass-encased exhibition model of a receiver of the type introduced on the market with the beginning of public television on Apr. 30, 1939.

future, and several research organizations have accordingly addressed themselves to the problem of producing large pictures of adequate detail and brilliance. One of the most direct approaches is the production of a small and very brilliant picture on the screen of a small cathode-ray tube and the employment of a lens to project this image on a conventional viewing screen.

The expense of the projecting lens and the fact that the cathode-ray tube must be operating at very high voltage to obtain the requisite brightness have limited such apparatus to the professional field, although eventually such projection-television receivers may be available for the home. Projected all-electronic television of this type has been demonstrated in the United States by the RCA and NBC organization and by the Baird Television interests of England. Several large screen television projectors have been installed in theaters in England, but since television's European black-out in September, 1939, these installations have not had program service.

Another successful means of producing large pictures, developed by the Scophony Company in England primarily for use in theaters, makes use of a highly refined mechanical system capable of operating directly from television signals intended for cathode-ray tube receivers. Home models of the Scophony receivers were put on the market in Great Britain, but they were much more expensive than corresponding cathode-ray tube receivers producing smaller pictures.

There is little doubt that larger pictures are required before the full capabilities of the present television system are realized, but this problem will be solved in due time. In the meantime, the 8- by 10-in. picture is capable of giving satisfaction to the small family group for which it is designed. Smaller tubes used in the less expensive receivers, are capable of producing satisfactory pictures when viewed from a correspondingly closer distance.

Again looking far into the future of the development of electronic television to provide still further benefits, the laboratories of the Radio Corporation of America are now conducting research on methods and systems for producing television in color. Demonstrations have been given in the laboratory of images of still pictures in color. The problems of color television are even more complex than those of television without color and a great deal of research will be required before it can become more than a laboratory development.

CHAPTER III

PUTTING THE TELEVISION SYSTEM TO WORK

The television system described in the preceding chapter has been embodied in the television broadcasting plant of the National Broadcasting Company in New York City. In this chapter, this plant is described from the viewpoint of its utility as a practical working system, operated for the purpose of producing and disseminating programs to the public on a regular schedule.

Before discussing the NBC plant in detail, however, it is desirable to investigate an important factor that influences the effectiveness of the television system. This factor is the distance over which the transmitting system can produce a satisfactory television signal. Here there are many apparent contrasts with the corresponding range in ordinary sound broadcasting. Not all these contrasts are fully understood.

The service area of a television station depends on four important factors: the power of the transmitter, the height of the transmitting antenna, the interference that the television signal encounters at the receiving location, and the character of the terrain over which the signal travels. Of these four factors, the one usually given the most attention is the height of the transmitting antenna. The reason for this attention is the fact that the reliable service range of the transmitter may be measured, all other factors being equal, by the distance to the horizon as viewed from the transmitting antenna. Reception beyond the horizon is not unusual, especially if the receiving location is at a high altitude and if an elaborate receiving antenna is employed. Thus, good reception of NBC programs has been reported near Albany, N. Y., at a distance of roughly 130 miles, whereas the horizon distance from the NBC transmitting antenna is about 45 miles. But such long-distance reception is the exception rather than the rule. Experience has indicated that the horizon is the usual limit of reliable reception unless special pains are taken at the receiver.

It is true, of course, that virtually every portion of the country is within range of one or more sound-broadcast stations, provided that the listener is satisfied with "secondary coverage," *i.e.*, a program occasionally marred by fading and distortion or by noise caused by natural or man-made interference. No such statement can be made concerning television. Reception beyond the horizon is not impossible; but beyond this limit, reception may be so rare that it may occur only a few days in a year. It thus appears definitely that the rural areas cannot be covered with a signal from a television station located at a great distance. The only answer to rural coverage, now in prospect, is the installation of a great many local television stations, one for each area of 100 miles in diameter. Eventually this problem will be solved no doubt, but at present the prospect of universal coverage of rural areas by television stations is remote.

Coverage of the cities is a very different question. It is quite within the realm of immediate possibilities to cover nearly all the urban population of the country with television transmitters located in the 96 metropolitan areas of 100,000 population or more. This is true because within 25 miles of these urban centers (taking 25 miles as the reliable range of a television station having an antenna height of about 500 ft., the maximum to be erected in many cities), 55 per cent of the total population of the country resides. The population in these areas is sufficiently dense to support the system, once receivers are distributed within these regions in sufficient numbers. The remaining 45 per cent of the population must apparently do without television until the distance restriction is removed or until the economics of the country justifies an enormous investment for local stations.

The technical problem of long-distance transmission for television is in sharp contrast to that in conventional sound broadcasting. This contrast arises principally from the difference in the frequencies on which the two classes of stations operate. Sound-broadcast stations operate on frequencies from 550 to 1,600 kc., which gives room for 106 different operating frequencies. Within this region, by judicious allocation of individual assignments to the frequencies, more than 700 broadcast stations are accommodated throughout the country, and as many as 20 stations are accommodated within a single city. Within

this same frequency range, assuming it were technically possible to employ it for television broadcasting, there would not be room for a single television station. The difference lies in the fact that the television signal is much more complex (relative to that required of a sound-broadcast station) and the room required in the ether is proportionately greater.

In order to find room for television stations in previously unassigned regions of the ether spectrum, and also because of the necessity of finding a carrier wave of high enough frequency to carry the complex television signal, the frequency assignments from 44,000 to 108,000 kc. were made by the Federal Communications Commission. In the frequencies assigned, room has been found for seven television channels. By judicious duplication of these channel assignments, it is quite conceivable that several hundred television stations might be set up in the country without any possibility of mutual interference between them.

But the characteristics of the television frequencies are found to differ markedly from the conventional frequencies of sound broadcasting. The conventional 540- to 1,600-kc. waves are reflected by an ionized layer in the upper atmosphere and are thus caused to follow the curvature of the earth, bounding back and forth between the ionized layer and the surface of the earth. This type of wave propagation accounts for long-distance reception of these conventional waves. When frequencies from 44,000 to 108,000 kc. are employed, however, the ionized layer does not reflect them or, at best, is capable of reflecting them only when highly unusual atmospheric conditions exist. The high-frequency waves accordingly penetrate the ionized layer and are lost in space outside our atmosphere. The situation is thus somewhat comparable to lighting up the countryside with a huge beacon lamp. The rays of this lamp will illuminate the land out as far as the horizon (as viewed from the lamp); but beyond the horizon, the light departs from the surface of the earth and is lost.

The waves employed in television do bend about the curvature of the earth to a slight extent, not by reflection from the ionized atmosphere but by an effect known as "refraction" of the waves. This slight bending effect accounts for reception beyond the horizon, but the refraction is accompanied by a very rapid weakening of the wave, so that very sensitive receiving apparatus is

required. Beyond about 200 miles, the refraction effect is overcome by the weakening of the waves, and reception ceases altogether. It is true that occasional freak receptions at hundreds of miles have been reported, but this reception must not be considered as dependable.

In view of the foregoing facts, it is common to assume that the limitation of reliable reception is limited to the horizon viewed from the transmitting antenna, with the foregoing reservations. This is the maximum reliable range. The range may be considerably less than the horizon distance if the conditions at the receiving location are unfavorable. Thus, if the receiver is located close to a busy highway, the ignition systems of passing automobiles may set up enough interference to make reception impossible even if the receiving location is well within the horizon distance. Likewise, if the power of the transmitter is low, the ability of the signal to override such interference is proportionately decreased. But if the transmitting power is 1,000 watts or more, and the transmitting antenna 500 ft. high or higher, then reception can be counted on in the usual case up to 25 miles from the transmitter. If the antenna is 1,000 ft. high, the distance is about 40 miles. The horizon distance in miles is about 22 per cent greater than the square root of the transmitting antenna height in feet.

Before leaving the matter of television coverage, it is well to point out that the limitation of distance is to some degree a blessing in disguise. In the first place, the distance limitation permits each of the available channels to be duplicated many times across the country. Since the total number of channels is limited, this is fortunate. If each station had a potential range of 1,000 miles or more, there could be only seven television stations in the whole country (within the range of frequencies previously mentioned—44,000 to 108,000 kc.). Twelve other assignments are available in the range from 294,000 to 300,000 kc. but these are not so technically or economically useful for public service at present as the lower frequency channels.

In the second place, if the television signals were reflected from the ionized layer and hence were capable of covering thousands of miles, it is very unlikely that the quality of the television images resulting from such reflected signals could support a satisfactory television service. Tests have already been conducted on con-

ventional wave lengths (using a low-definition system capable of being accommodated within narrow confines). These tests have shown that beyond the horizon (and in certain cases even within the horizon distance), the reflected signals are apt to give rise to "ghost" images, that is, secondary images somewhat fainter than the intended image and displaced some distance from it on the screen. These ghost images are usually distorted

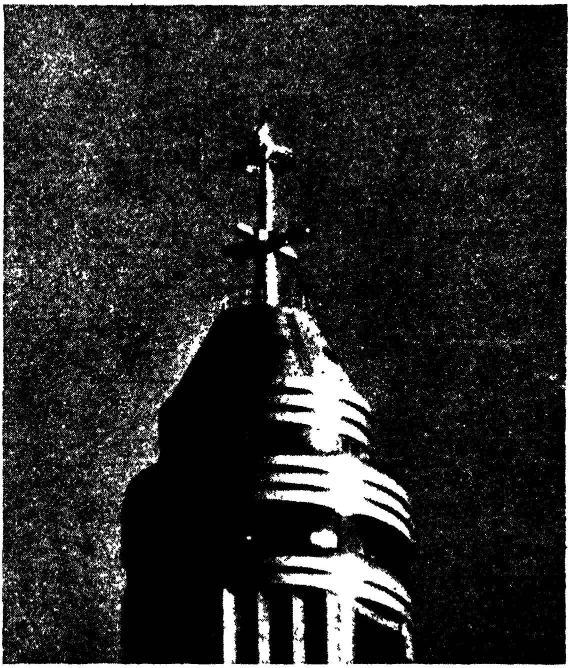


FIG. 10.—NBC television antenna atop the Empire State tower in New York City.

and change their position gradually as the reflected signal varies with the condition of the reflecting atmospheric layer. Although ghost images are not always prominent, they would constitute a definite limitation to the enjoyment of the programs during most of the time.

It follows, then, that if television images were capable of being received beyond the horizon, the received images would not supply a first-class program service, but they would interfere with the transmissions of other stations. It is perhaps fortunate that

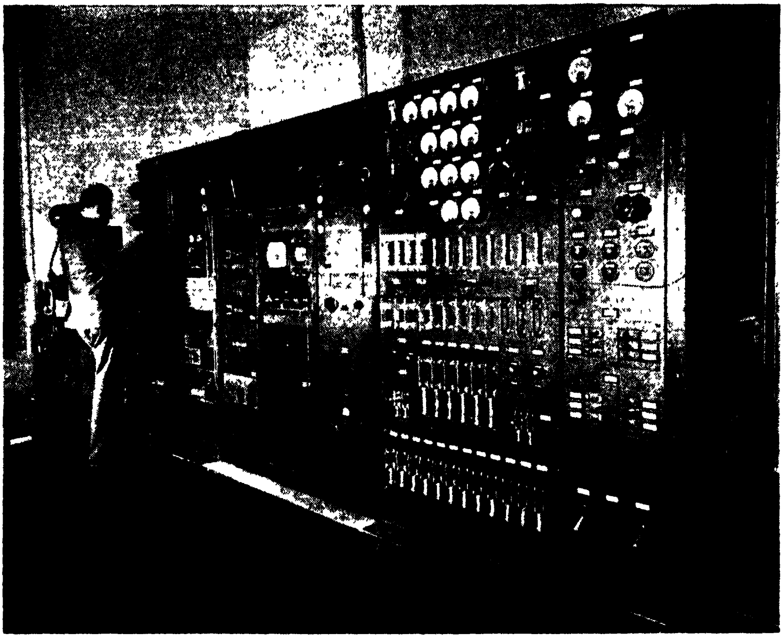


Fig. 11.—The control room of the NBC Empire State tower transmitter. The center rack contains a monitoring screen used to check the picture.

Fig. 12.—The main transmitting room at the NBC Empire State tower transmitter.

the distance of transmission is limited, since this limitation allows coverage by many stations, which can cater to the differing program requirements of different sections of the country in addition to providing programs of general interest from networks.

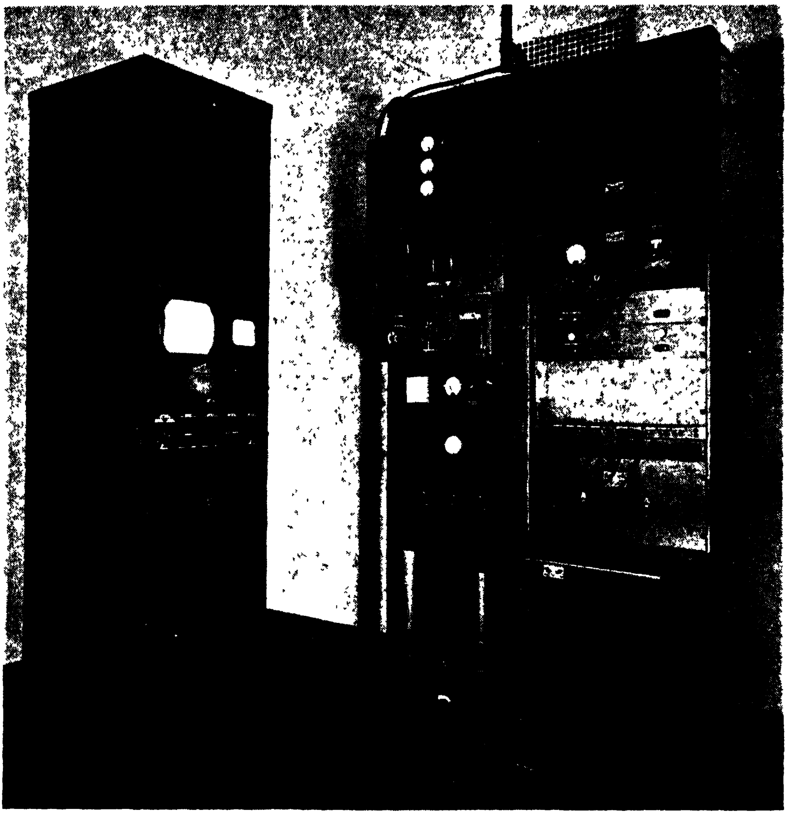


FIG. 13.—Ultrahigh-frequency radio relay transmitter installed in the tenth floor of the RCA Building. Television programs originating in Radio City may be relayed to the Empire State Building transmitter either with this transmitter or by a special coaxial cable between the two points.

NBC's television programs are radiated from an antenna mounted atop the tallest building in the world, the Empire State tower, 1,250 ft. above the street. The dependable range for pictures of good quality is about as far as one can see on a clear day from the Empire State observation roof, that is, 40 to 50 miles. The coverage of this single transmitter thus embraces an area of

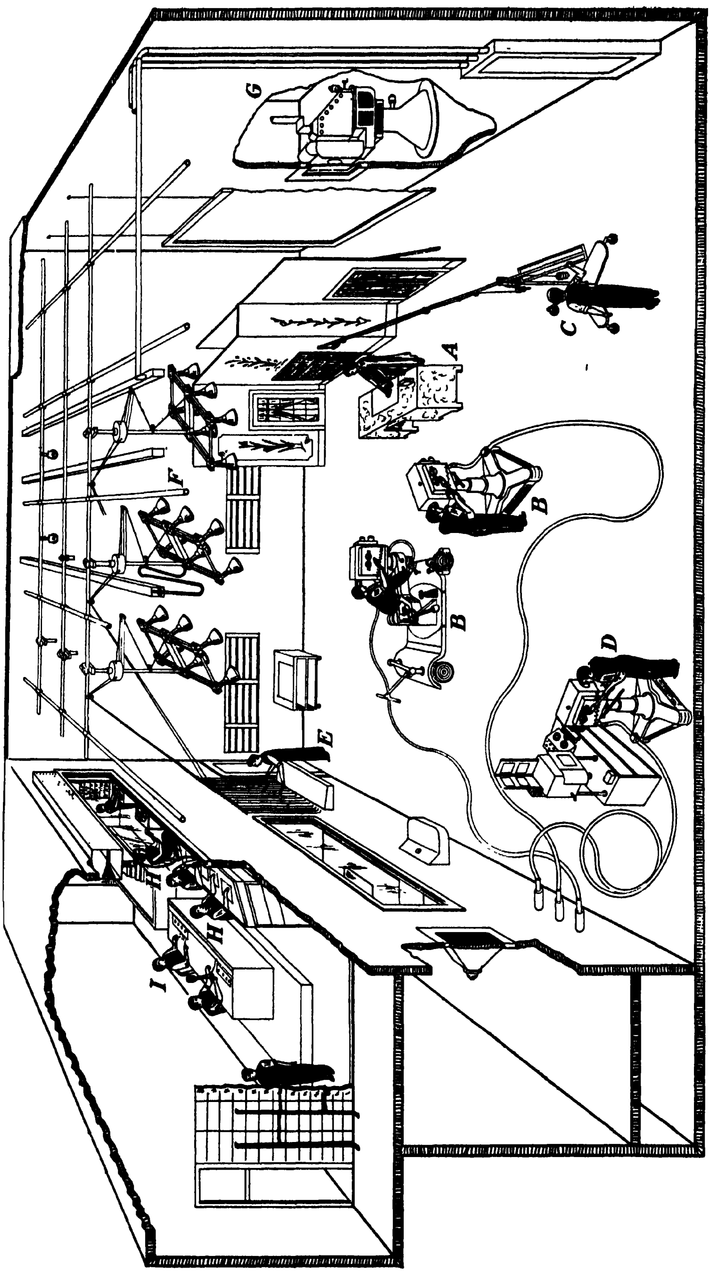


FIG. 14.—Diagram of live-talent studio. *A*, scene being televised; *B*, cameras picking up scene; *C*, microphone boom picking up sound accompanying the scene; *D*, camera picking up titles and video effects; *E*, lighting engineer at lighting controls; *F*, lights (only a few shown) may be adjusted at *E* for any angle; *G*, slide projector for rear screen projection of scenery; *H*, sound and video control engineers; *I*, program producer and technical director. There are additional people in the studio during a broadcast such as the property men, lighting assistants, and technicians.

approximately 8,000 sq. miles, inhabited by more than 10,000,000 people. Directly under the antenna, on the eighty-fifth floor of the Empire State Building, is the transmitting equipment, where the television signal is conditioned for its journey through space.

The transmitter is linked to Radio City, about 16 city blocks north of the Empire State Building. The connecting coaxial cable is nearly a mile in length. A radio relay link between

FIG. 15.—The live-talent studio during an actual broadcast showing the cameras, microphone boom, and technical personnel in action.

studio and transmitter is also used. The indoor live-talent programs originate in a studio which has been converted from sound broadcasting. Studio 3H, the main studio, shown in Figs. 14 and 15, is a high-ceilinged room the general aspect of which resembles a composite theater stage, motion-picture set, and radio studio. Included in the room are movie paraphernalia, cameras and lights, theater props, scenery and drop curtains, radio apparatus, microphones, and sound effects. Numerous frosted lamps are suspended from the ceiling. The walls are silver-toned surfaces with a high light-reflecting value to enhance the degree of illumination.

Three cameras are mounted on movable supports fitted with rubber-tired wheels to permit quick and easy movement. Ceiling and floor lights can be lowered, raised, and moved about at will. The microphone is suspended from a long boom which is made to follow the movements of actors. The number of wires and cables and telephones makes the studio one of the most com-

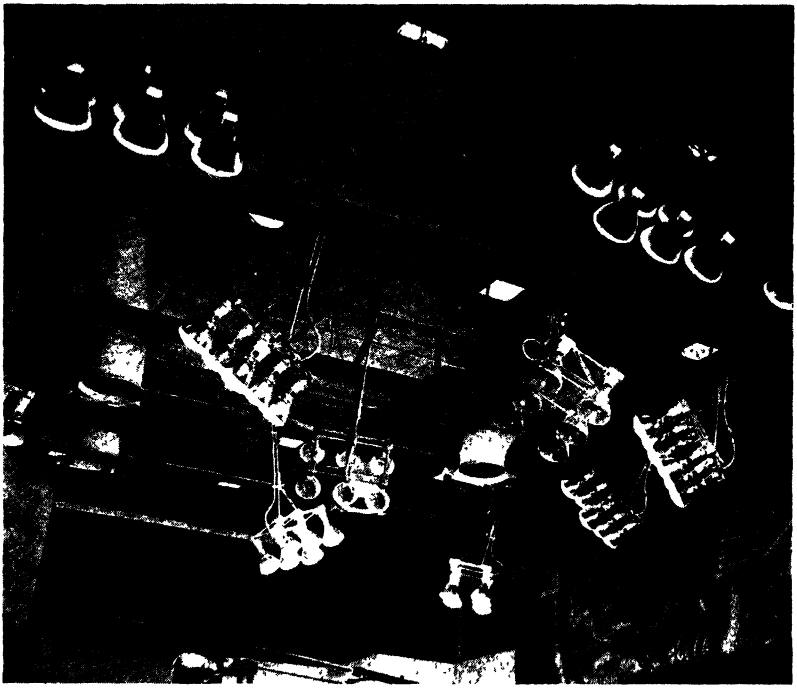


FIG. 16.—Lighting units are mounted on a grid attached to the ceiling. Each unit may be rotated and tilted at any angle by remote control.

plex, but thoroughly coordinated and synchronized, systems of communication ever devised.

The programing side of the system is the responsibility of a handful of men selected for this work by virtue of training, experience, and aptitude. The studio personnel includes camera operators, lighting engineers, studio managers and assistants, and porters who handle camera "dollies" and cables and assist the lighting engineers.

Up to the present, it has been found well-nigh impossible to train personnel properly anywhere except in a television studio.

Experience indicates that it is not reasonable to expect to produce more than one complex program per day per studio crew, on a schedule of 4 days per week for each crew. Rehearsals require such application and concentration that personnel fatigue

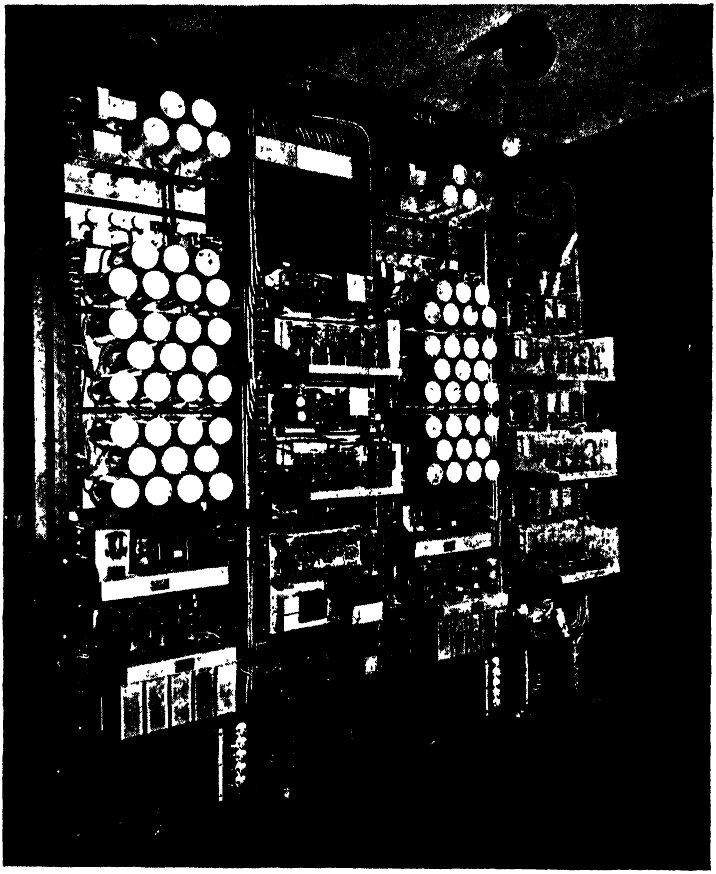


FIG. 17.—Part of the apparatus "behind the scenes." These are the synchronizing signal generators which form the heart of the television system. They create the timing impulses which keep the receivers and transmitter working in unison.

is an important factor. If a staff is overburdened with detail, responsibility, or work, the quality of the broadcasts may be seriously interfered with.

Overlooking the studio proper, but separated by sheets of plate glass and brown gelatin to subdue the bright lights, is the master

control room. Behind the glass panel, which affords a general view of the studio, stand the control panels at which are seated the program producer, technical director, and sound- and video-monitoring engineers. These men supervise studio operations, besides "monitoring" both sight and sound signals before they are relayed to the Empire State transmitter.

Program producers supervise all studio activities. Sight and sound engineers are charged with supervising the quality of a program from a technical standpoint. Since all the men at the control console must exercise personal judgments and opinions, they are similar to a jury. The jurors' decisions are among the crucial factors in every live-talent broadcast.

As better arranged studios, more flexible lighting, and a revised system of controls become available, it may be possible to increase efficiency in the use of man power.

At present, NBC employs the following types of studio personnel in the production of programs:

PRODUCTION:

Program producers.
Studio managers.
Assistant directors.
Scenic designers, art directors, and make-up men.
Property, sound-effects, and special-effects men.
Writers.

ENGINEERING:

Technical directors.
Video engineers on controls.
Sound engineers on controls.
Sound-boom engineers.
Lighting and special-effects engineers.
Camera operators.
Assistants.

TECHNICIAN:

For lights and dollies.
For scene shifting.
For general utility.

When motion pictures or other projections are a part of the dramatic production, the following additional personnel is necessary in the film-projection studio:

Video-control engineer.
Sound-control engineer.
Projectionists.

The customary procedure of producing a program with the present facilities and personnel normally follows a definite routine.

A program begins with an idea, which may reach the program manager, to whom all program producers are responsible, as a

FIG. 18.—The master control room overlooking the live-talent studio. The three men in the front row, from back to fore, are; the video engineer, the sound engineer, and an engineer handling music and sound-effects turntables. Behind these three are the technical director in the back and the program producer in the fore.

suggestion from an associate or from a company official or from some outside individual or agency. No matter whence they originate, all suggestions gravitate to the manager's desk, where they are sifted and appraised for television. Decision rests with him and the television executives.

After a program or a script is chosen, the necessary production machinery is set up. The program producer meets with the

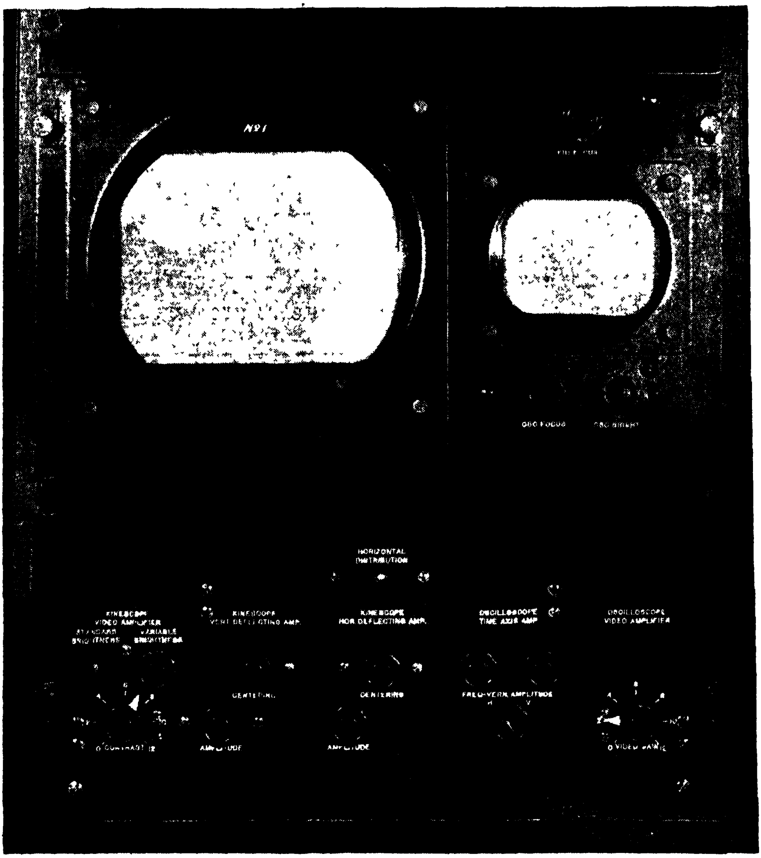


FIG. 19a.—A monitor used in the control room. The larger of the two screens is equivalent to a home-type receiver, and the smaller is the screen of an oscilloscope which shows the engineers the electrical equivalent in the form of a wave shape of the actual image being observed. By observing both of these screens the engineers adjust the television signal to insure best reception in the home.

technical director, and they sketch a plan for running the studio during production. Subsequently, the scene designer is called in, and together they confer on settings and properties.

If the script is protected by a copyright, the established NBC Script Division attends to clearing the television rights. If revision or adaptation is necessary, it is made by the program producer or by a writer of the Script Division.

At the time scenery is discussed, the sight-and-sound-effects men are assigned to prepare titles, miniature models, trick effects, and special lighting and to assemble the necessary sound-effects apparatus. So-called television sight effects are made possible by various devices built to order. They do not, as in the movies, involve tricks with the camera itself, largely because at present it is simpler to create these tricks before the camera's eye than to have the camera participate in the making of the trick.

All sorts of ingenious gadgets and inventions have been devised and are being devised to deceive the camera's eye. Illusions involving camera lenses and optics are possible with television where sufficient studio space allows producers to utilize the inherent flexibility of the electronic camera and the electronic system. Television can duplicate many of the familiar movie-camera tricks such as double exposure and composite shots.

FIG. 19b.—A photograph of the two screens shown in Fig. 19a, taken during a broadcast.

After studying the script, the director concentrates on casting. He will consult the television-talent file which contains photographs and detailed information about the careers of hundreds of players, listed according to aptitudes and specialties. The talent classifications are: character players, ingénues, leads, comedians, singers, dancers, acrobats, juveniles, diseurs, jugglers, prestidigitators, and professional models.

The chosen actor is first asked to read his part; and if the producer is satisfied, he invites him to appear for rehearsals.

Television production has so many aspects that it is essential to chart all the current activities on a production sheet designed to show at a glance what is to happen day by day and hour by hour. Scenery must be built on schedule; properties, costumes, and make-up delivered at a specified time; engineering operations must proceed according to prearranged schedule.

In order that two or three programs may be prepared simultaneously, rehearsals are scheduled so as not to interfere with broadcasting operations. While two or three programs are in rehearsal, several more are under active consideration, and at least one is ready to be broadcast. The success of programing depends upon the fulfillment of prearranged schedules. If any operation fails to happen on time, a general reorganization of all schedules is called for.

The first rehearsal gives actors an opportunity to read lines and perhaps walk through the action. It is attended by the actors, the technical director, and the studio manager who assists the producer in the production and management of the show. The manager supervises the placing of scenery properties, dressing rooms, and make-up facilities and arranges for music and sound and sight effects.

The proper coordination of all personnel and activities makes it imperative for the producer to visualize all the play action and the camera positions. Smooth continuity is the essence of television drama, and the better a producer plans his action and camera positions in advance the more speedily does the production get under way.

At present, the rehearsal-broadcast schedule is in the ratio of 10:1 up to 20:1. In other words, if a given program requires 1 hr. for broadcasting, the actors will require from 10 to 20 hr. for rehearsals.

After the preliminary "line" rehearsal, the cast goes through one or two studio rehearsals with cameras, and the last details of action are worked out to the producer's satisfaction. The object of studio rehearsals is to harmonize the camera routine and the acting technique with the mood and action of the play and also to coordinate the efforts of all the principals involved in the productions. The final dress rehearsal attempts to simulate

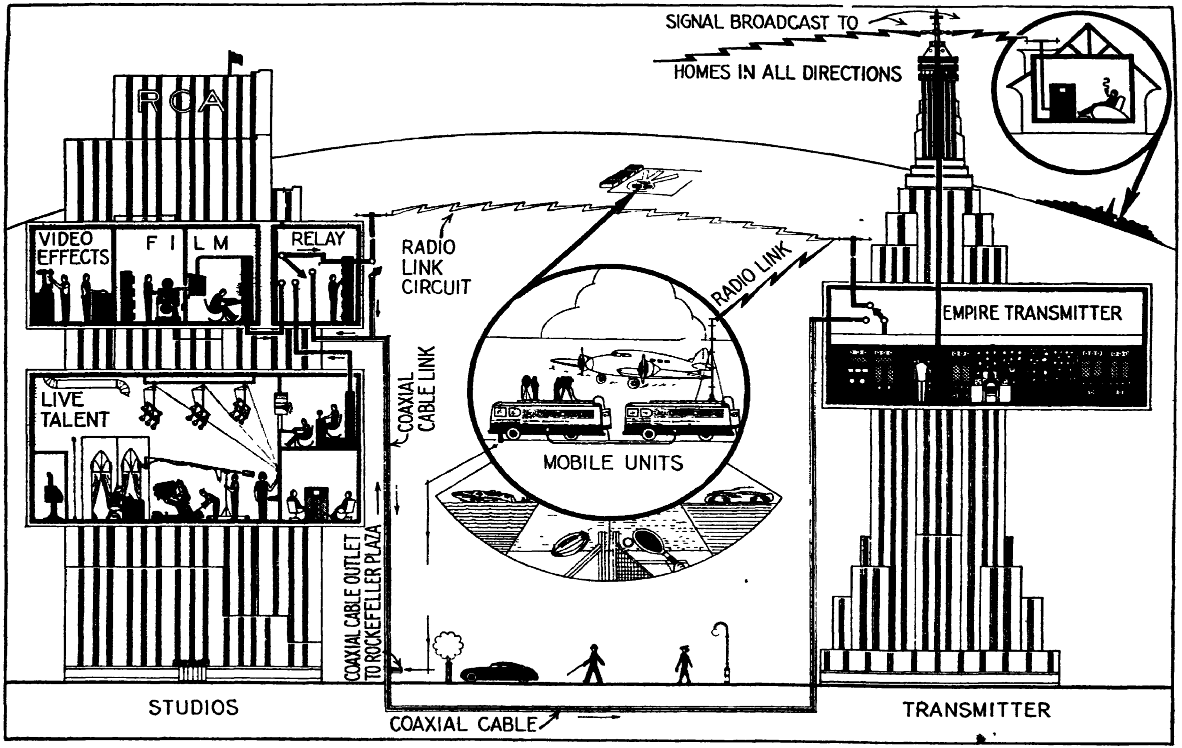


FIG. 20.—The three sources of program origination; live talent, film, and outside pickups; and the methods used to relay the television signal to the main transmitter at the Empire State tower for rebroadcast to viewers in the New York area.

broadcasting conditions so that any inherent defect or shortcoming may be checked on monitor apparatus which reproduces the program as it will appear in the homes.

To give a concrete example of television-drama production technique, we reproduce on page 225 the complete shooting script of "The Three Garridebs," a Sherlock Holmes mystery adapted by Thomas H. Hutchinson from a short story by Sir Arthur Conan Doyle. This script illustrates the split-second coordination that is required of every member of the studio personnel. Not only must the actors work accurately on their cues; so must also the camera operators, the engineers in charge of switching the cameras, and the technicians in charge of the lights and the microphone boom.

CHAPTER IV

TELEVISION PROGRAMING—BASIC CONSIDERATIONS

In building up a television service, the first essential is to ascertain public tastes and preferences and to key programs to them as closely and promptly as possible. Experience in sound broadcasting and 3 years of experimentation with television material indicate that what people will demand from television is entertainment, news, information, and enlightenment on life in its various aspects. The success of sight-and-sound radio will depend on how well broadcasters meet certain minimum technical and artistic standards set by the public.

On this score, the broadcasters of America have a knowledge of public tastes that no other group, save the motion-picture industry, enjoys. In the 12 years since network broadcasting began on a nation-wide scale, NBC and the other network companies have gained a wealth of experience in supplying sound programs to the public. Besides developing and testing program techniques, these companies have established artist services, built up coordinated sources of spoken as well as musical program material, and established solid relations with virtually every branch of the entertainment industry. This backlog of experience, material, and talent is an invaluable asset in the establishment of a television-program service. Already NBC has found its regular "service" departments, set up primarily for sound programs, of great value in its television activities. Other companies entering the field will find their sound-program lore of similar value. There are distinctions to be made, of course, between good sound material and good television material. But broadcasters will find that they can lean heavily on their sound-radio experience in making decisions on the merits of different television programs.

In choosing material during the early stages of television, it must be remembered that a prime function of the service is to promote distribution of receivers. When programs become so

inviting and arresting as to attract and hold an audience, more and more people will have the desire to own television receivers. The television-program service available, or in immediate prospect, must be good enough to justify the increased cost of a television set as compared with the cost of a sound receiver.

A survey of program sources has disclosed that more diverse and interesting material can be placed before the television audience than that of the stage or sound radio. Not only can broadcasters originate their own programs; they can adapt much material from literature and other entertainment mediums and draw on science, the arts, news—in short, any manifestation of nature or human activity adaptable to pictorial and sound presentation.

The most utilitarian feature of television lies in broadcasting events *exactly when and as they happen.* What the current television audience craves from television is "hot" news—the "hotter" the better. This preference is natural, for it is predicated on the understanding that television is ideally fitted to relay news events.

Those who anticipate that television will bring any sudden revolution in popular information and entertainment are deluding themselves, for expansion and popular acceptance will be gradual. The prevailing structure of popular entertainment and culture will accommodate itself to television without major displacements.

Although in the beginning television will lean for its program technique on the stage, the motion picture, and sound broadcasting, it will in time acquire an individual tone, a pace, an approach—a style with qualities all its own and unlike anything that has gone before. Already, those working day by day with programs see definite hints of the character and spontaneity heralding the arrival of a truly new type of programing.

In fact, it is becoming clear that the word "programing" is perhaps too narrow a term for what television can offer to the public. The word programing infers a staged presentation that is well planned in advance and that therefore might well find its way to the audience through other channels, such as sound motion pictures. Much television program material fits this definition. But a great deal of it falls outside the "staged" category. In fact, the spontaneous program, which "takes the audience some-

where to see what is going on when it is going on" is perhaps the basic type of television material, since this type of program cannot be offered to the public in any other way.

It is in this latter sense that the term "television programing" infers a new form of entertainment, one that offers more than other mediums can offer. And it is on this score that television can be expected to supplement, rather than to displace, other forms of entertainment, including sound radio and motion pictures.

From written reports and from actual observation of televiewers seated around receivers, it has been proved that the eye is more critical and less patient than the ear. In sound radio, any person with a fairly pleasing voice and an interesting story can hold an audience from 15 min. to an hour. The appeal in this case is directly to the ear and the imagination. But with the sight and sound appeal of television, a great demand is made for the whole attention of the viewer, and only a strong personality will command interest and attention. To some extent in television, interest can be heightened by switching from one camera to another to add interest. But even this artifice has limitations that make it necessary to abbreviate a speech or to turn from the speaker to pictures of people or things that he is discussing and thus use the voice as background narration to the images televised.

As television broadcasting becomes general, it will doubtless affect the standing of persons in the public eye. When a speaker addresses the public through the microphone, he goes on trial in popular estimation, and his personality is judged from the way in which it finds expression in his voice. Now if we add the more critical sense of sight to the sense of hearing, the public can be even more critical in the appraisal of personalities who, figuratively, come into the home.

The newsreels have established a superficial familiarity between popular personalities and the cinema public, but rarely does any celebrity appear before a newsreel audience for longer than 2 min. Television makes allowances for much longer and more frequent appearances by public figures, and thus we establish a more personal observation of national figures.

Many concrete observations have been made from time to time in the course of experiments with television. To the pre-

vious statement that individual speakers soon tire the eye might be added the significant fact that it is difficult to build an interesting program from the performance of single musicians or small ensembles. Such a program soon becomes dull and monotonous. It is apropos to recall that from 1927 to 1930, Hollywood produced numerous film shorts made around orchestras, virtuosos, and scenes from standard operas. Such films did not capture the eye or the imagination and were soon abandoned.

A program type of very great potential value is the educational or, more properly, "factual" form. It is no secret that the public appears very much to prefer being entertained to being instructed. In television, the wider flexibility of the medium and the fact that the programs are introduced directly into the home make it possible to offer factual material in a thoroughly vital way and hence to command audience attention to subjects that would not be offered except in schools.

The presentation of factual programs must of course be based on good showmanship. This means that the emotional basis for the program must be appropriate. But appropriate emotional bases for factual television programs are not hard to find. The urge to self-improvement; the urge to keep up with the rest of the crowd; the urge to be in fashion, intellectually as well as sartorially; the urge to protect one's self and one's dependents—all these are among our most trustworthy emotional stimuli. Television programs built around them can (and in fact already do) command the highest degree of audience attention. The popular magazines have found that it is worth while to devote space to achievements in medicine and community health, to the human aspects of economics, even to a new species of fish thought extinct several million years ago. Television will do well to take advantage of the similar, in fact broader, opportunity open to it. All that is required is a proper analysis of the emotional basis of the program and some imagination in presenting it in thoughtful, convincing, and sympathetic terms.

The time unit around which sound-radio programs are built is the 15-min. period and multiples thereof. Many of the sound-network programs last 30 min., or two periods. Single programs very seldom exceed an hour. For television, there is reason for reducing the 15-min. unit to a 10-min. unit or multi-

ples thereof. One determining factor is the motion-picture tenet that the normal interest period for a motion-picture short is about 10 min. A second reason lies in the fact that since much more literary and dramatic material can be packed into a television show than a sound-radio show, 10 min. is enough to express one idea.

Again, more frequent shifts are desirable in the aspect of the television picture than on screen or stage. This is due to the fact that the eye, while observing a stage set (or a wide-angle motion picture), makes its own changes to various parts of the scene to maintain interest, whereas in television the camera must take the eye to various points of interest in the scene.

It appears to be inadvisable to broadcast most programs more than once. On the second broadcast, the audience is likely to become hypercritical and to lose interest. However, from what has been learned to date, it appears that with a careful choice of hours and dates, a program of unusual quality and interest can be broadcast twice without taxing the public patience.

At present, television actors are drawn mainly from the legitimate stage and sound radio. Although television art may be regarded just now as a composite of the various dramatic arts, actors must accommodate themselves to certain new conditions and limitations prescribed by the new medium. A theater actor may move about a large stage with few restrictions on his movements upstage or downstage or from left to right. Although spectators cannot follow the detailed movements of, say, half a dozen stage actors, they can easily follow the main activities while hearing dialogue.

When intimate action appears on any part of the stage, the audience focuses attention on that point and imagines a close-up of that portion of the scene. While concentrating on a close-up, it absorbs general impressions from the rest of the stage. From the effects made possible by such conditions have sprung the dramatic conventions known collectively as "stagecraft." Most actors who have appeared on television programs have been trained in these conventions.

Television acting is apparently giving birth to a set of conventions tailored to meet the special requirements of the new medium. In the first place, each actor must understand that he

cannot be seen directly by televiewers, that all his actions and expressions must first be picked up by the eyes of cameras.

In a theater, each actor assumes that the audience has as wide-angle vision as he possesses, but he must be taught that a television camera does not see at such wide angles and that, hence, the televiewer is totally ignorant of what happens outside the *camera's* field of vision. For this reason, television producers have found it helpful to use more than one camera for studio productions. This enables a televiewer to see continuous action, and it also allows the producer instantly to shift from one scene of action to another.

The first television programs were primitive, and producers had their hands full manipulating one camera. For the year and a half prior to September, 1938, during its field tests, NBC employed two cameras on studio programs. Beginning in November, 1938, three cameras were used; and five may be necessary when more elaborate productions are undertaken.

The television artist's range of action is more confined than on the stage, largely because the camera's depth of focus is limited. The actor may move freely from left to right, or vice versa; but if he advances or retreats too rapidly, he risks the hazard of suddenly appearing fuzzy. This restriction of movement may force him into unnatural positions, and it also creates difficulties in the way of producing dramatic effects. Improvements in camera pickup tubes can be expected to improve the depth of focus in the future.

Where more than one camera is used, it may be a factor for the actor to know to which camera he is playing; this may further hinder his freedom of action. The camera operators, of course, have the responsibility of capturing the motion, but they must have a high degree of coordination with the actors.

In first-class theater productions, at least several weeks are allowed for rehearsals before the opening night, but the cost of television obliges a producer and actors to prepare a 30- or 60-min. performance for broadcasting in 5 to 20 hr. of rehearsal.

Another requirement of television production makes it difficult for sound-radio actors to appear on programs. Television actors must learn lines by heart; and although radio actors are skilled in the subtle shading of words, they have not learned to coordinate words with action. By no rational process can we

adapt the usual microphone technique to television, because in television, as on the stage, we must follow Shakespeare's prescription and "suit the action to the word." Even actors trained for motion pictures find it necessary to adapt themselves to television.

In motion pictures, the action is shot scene by scene with convenient intermissions. The director rehearses his cast until he is satisfied with its performance. The actor need not memorize lines for more than one or two scenes at a time. After shooting a long succession of scenes, the final picture is assembled by editors in the cutting room. The actors themselves seldom realize the full scope of the action until they have seen the completed picture on a screen.

In television, the actor must know his lines verbatim before he steps up to the camera. There are no interruptions or pauses in a television performance. There are no retakes, such as may occur in motion pictures to achieve an improved performance. In television, if a mistake is made it must be "covered up" quickly and naturally. This requires considerable adroitness on the part of the actors. When the show is under way, the player is on his own, for better or worse; and if he forgets his lines, he must improvise. In television, it is hard to prompt a stumbling actor. The producer sits in the control booth behind a plate-glass window, and the only way he can reach an actor is through his studio manager with whom he is in telephonic communication. The actor must shoulder the responsibility of making a scene continuous.

Sound-radio artists, especially comedians, found it helpful to play to a studio audience, and it has become customary for spectators to be present at many sound broadcasts. But in television it will apparently be difficult and expensive to construct a plant so that an audience may be accommodated in full view of studio operations.

Essentially, what the radio artist does is to divide himself into two components: one, the visual component, acts especially for the studio audience, while the other, the vocal component, addresses itself mainly to the unseen audience. Frequently, the studio audience has difficulty in hearing the words or music voiced by an entertainer into the microphone, but the unseen audience gets the intended effect. To some extent, inability of

the studio audience to hear is offset by the expressions and stage actions of the entertainer.

But if a television artist attempted similarly to cater to a studio audience as well as to a distant audience, he would court failure. The numerous technical operations incidental to a television production would interfere with the entertainment of the studio audience. Television-studio design is far more complicated than sound-studio design, and provision for a television-studio audience might be made at the expense of some vital production function. A first requisite of sight programing is to have control rooms where the occupants can observe technical and dramatic activities, and therefore these positions must have preference. Studio sets, lights, cameras, and special effects would be in the way of spectators.

It cannot be denied that with entertainment such as vaudeville, comedy, or monologue, it may be desirable to give performers the benefit of audience reaction. Laughter and applause are contagious, and they spread rapidly when the proper cue is given. With certain types of shows, it is necessary that entertainers time their lines to the audience's reaction. Without precision timing, the best of humor may go flat.

A counterpart of a studio audience in television might be a group sitting in a viewing room before a receiver. In certain instances, the group's reaction could be "piped" into the television system to give the distant audience a feeling of theatrical atmosphere and to stimulate their interest. It might also be desirable to introduce the laughter and applause into the studio by means of a loudspeaker and thus help the performers in timing.

Television productions sometimes have special problems, as in "The Three Garridebs." It was necessary for Holmes and Dr. Watson to exit from one scene and enter the succeeding scene with an almost complete change of costume. Since it was impossible to accomplish this instantaneously, the producer introduced a "cover scene," a familiar device in dramatic work on stage.

A cover scene on the stage requires other actors to sustain attention while the main characters are absent. But in "The Three Garridebs," a cover scene was inserted without resorting to the use of additional actors. A motion-picture sequence of

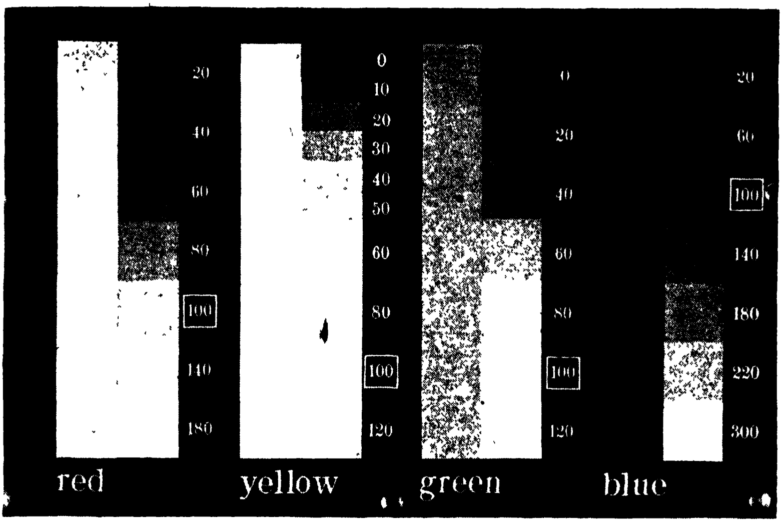
Holmes and Dr. Watson riding to their destination in a hansom cab was inserted, and in this way the transition from the Holmes living room to the front door of the Garrideb house in London was easily managed. The movie sequence was photographed in Central Park and in Jackson Heights, L. I., several days before the broadcast.

FIG. 21.—A portion of the motion-picture strip used as a "cover scene" during the television production of "The Three Garridebs."

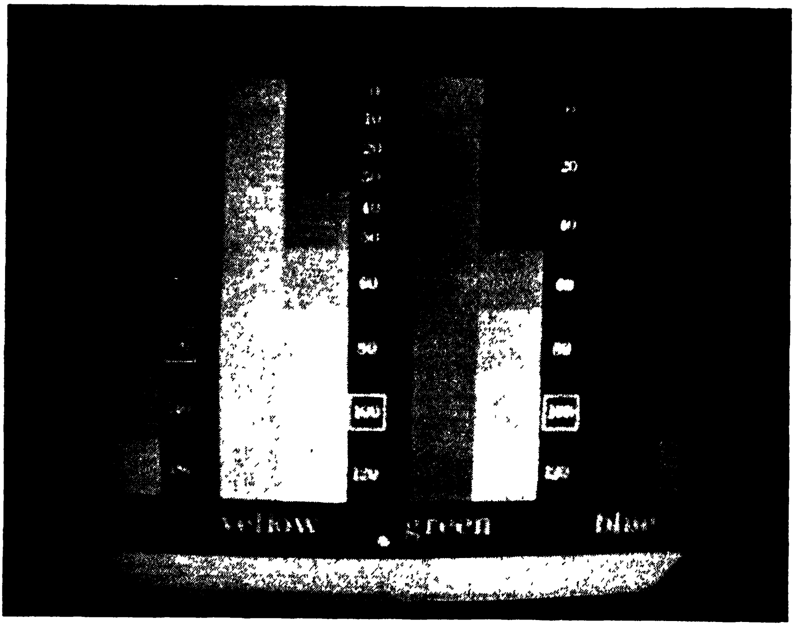
Another effect found useful in holding attention during a cover scene is accomplished by focusing the camera on the actor whom another actor is addressing, while the latter walks to an adjacent set and changes his costume en route. Such complexities and obstacles multiply the possibilities of failure. Once the camera action begins, an actor cannot turn back to correct mistakes, nor can he repeat what has already been broadcast.

At present, the normal rehearsal time without cameras for a dramatic production of 1 hr. in length is about 6 hr. Then the actors rehearse about 12 hr. before the cameras, assisted by the technical staff of sound and sight engineers. During this latter period, details of camera angles, lighting, and acting positions are carefully worked out. Not only the actors but members of the technical staff, from engineers to porters, must memorize the sequence of action and the individual part that each one has in the general scheme. The entire studio personnel must function on cues. It has been found necessary to start rehearsals at least 7 days in advance of the broadcasting date.

When the field tests were begun in 1937, the color-response curve of the Iconoscope was so distorted as compared with the eye's color-response curve, that it seri-



(a)



(b)

Fig. 22.—A television reproduction (b) of a standard photographic film color chart (a). The comparison of the fidelity of reproduction of the gray equivalents of the colors as here reproduced using standard panchromatic photographic film is considered to be very close.

ously restricted the use of natural color contrasts and harmonies in costumes and make-up. Since that time, however, engineers have improved the Iconoscope's color response so that there are fewer worries regarding make-up, which is usually the standard kind used in motion pictures. In fact, many actresses have appeared before the cameras with ordinary street make-up. Furthermore, the producers are no longer seriously handicapped in regard to costume colors.

Strange things happened in the days before the system's color response was improved. Once a man dressed in a tuxedo appeared on the television screen with black lapels while coat and trousers were gray. Another time, televiewers saw a girl cut in half by a red sash, whose color blended with the background. These difficulties are not encountered with the newer equipment.

CHAPTER V

STUDIO PROGRAMS

Television broadcasters look upon the field of drama as a prolific source of program material. However, after examining numerous published and unpublished scripts, the National Broadcasting Company program staff has concluded that the most effective presentation requires varying amounts of rewriting or special adaptation. At this stage of television, the author, director, and producer must make concessions to the limitations of the medium, since in practically all cases the requirements differ basically from those of sound radio, the stage, or motion picture.

At the outset, it is necessary to establish definite standards that television productions must meet. In sound broadcasting, a high level of taste, ethics, and morals has been established—so much so in fact that the slightest lapse is highly noticeable and brings a correspondingly swift public reaction. In television, it goes without saying, the same standards are necessary, but the opportunities for offending against them are multiplied by the fact that the program may be seen as well as heard. The program director must be alert to this fact and must scrutinize his productions with care to eliminate any possibility of offending good taste.

Generally, the problem of studio production reduces to one major consideration: competent personnel must be discovered and trained to do the work of fitting acceptable material to television needs. For the immediate future, since the securing of existing dramatic material may be expensive and time consuming (see Chap. XII), it may be necessary to follow Hollywood's system of engaging a staff of television writers and adapters while at the same time attempting to obtain rights to existing material.

Compared to other program material, a play is rather expensive to produce, because it entails the use of a maximum studio staff,

but the interest in well-presented drama partly offsets this factor. NBC has experimented with a wide variety of drama, notwithstanding the fact that a large number of copyrighted scripts were unavailable even for experimental broadcasting.

Dramatic literature embraces many great plays that sooner or later may be readily adapted to television programing. Whether comic or tragic, the play's central idea must have a significance and meaning worthy of dramatization. Characters must be clearly delineated as individuals, and each character must be indispensable to the plot. Television demands action even more insistently than other mediums demand it.

To create intimacy in home reception is a stern problem to all concerned in the creation, production, and transmission of television drama. To intimacy we might also add another factor—"instantaneity," which may be described as a quick, spontaneous, and compelling appeal to the emotions. Intimacy and spontaneity are realized virtues of televised drama, and combine to create a fascination that endows sight broadcasting with keen interest.

It is important to differentiate between the television-audience reaction and the reaction of a mass theater audience. In the traditional theater, the actor addresses himself to a visible, assembled audience; but in television, he addresses an unseen individual or family group through an electronic camera and picture tube.

As a distinctive form of drama, the television play invites sensitive and imaginative writers to express ideas with an individual literary style. The plot construction and dialogue technique follow traditional theatrical conventions, but, in addition, the playwright must cultivate an ear for sound-radio reproduction and an eye for camera imagery. By fusing these elements in his conscious thinking, he achieves the effect of television drama.

Engineers skilled in "sight effects" can assist in establishing locales, simulating the proper atmosphere, and they can introduce film sequences for transferring action from one place to another. Eventually, television drama will embrace more within its scope than the theater or cinema, but it will probably not revolutionize playwriting or alter the fundamental theories and concepts of dramaturgy that have come down through the centuries.

Since the inauguration of its public television service, NBC has televised from its studio an average of one full-length play or musical show each week. Many were Broadway dramas, some were produced with the original Broadway casts. Among these were, "The Donovan Affair," "Hay Fever," "Jane Eyre," "The Milky Way," "The Fortune Hunter," "The Farmer Takes

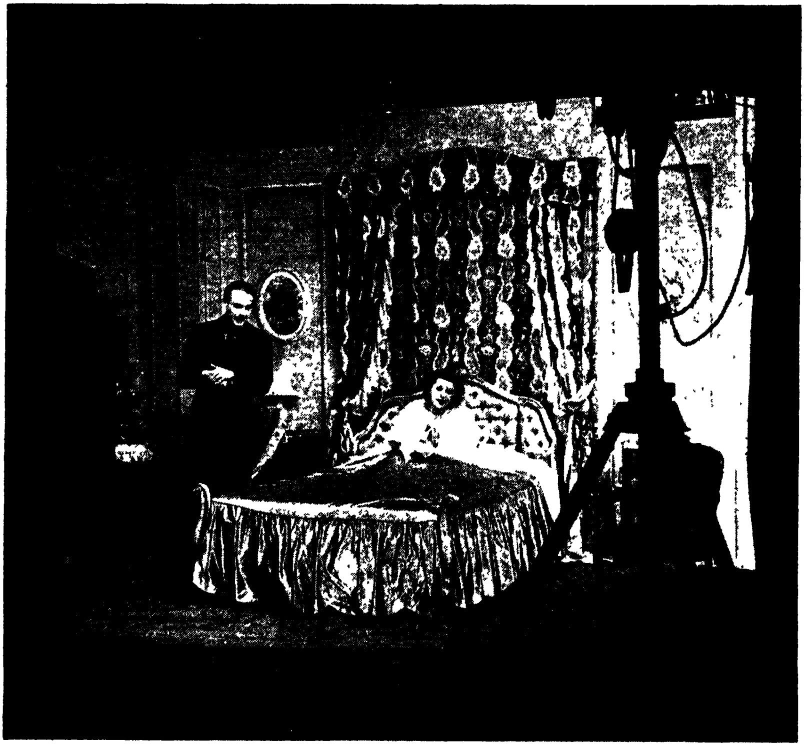


Fig. 23a.—Paul McGrath and Gertrude Lawrence in a scene from the Broadway drama, "Susan and God," televised from the NBC studio, June, 1938.

A Wife," "A Criminal At Large," "Three Men on a Horse," "Roosty," "Missouri Legend," and "Treasure Island." These productions ran from 1 hr. and 10 min. to 1 hr. and 45 min. All had a number of scenes. One of the most popular musical productions was "The Pirates of Penzance" produced with a full complement of accomplished and well-known performers, in

a shortened version lasting about one hour. A less ambitious, but nevertheless highly successful, musical offering was "Cox and Box" by Sir Arthur Sullivan.

In June, 1938, the NBC staff with the help of John Golden, Broadway producer, carried out an experiment that stirred wide interest among critics who were invited to see the result. A scene from the current Broadway drama, "Susan and God," was transferred *in toto* to studio 3H, where Gertrude Lawrence, star of the play, and Paul McGrath and Nancy Coleman of the supporting cast acted their roles before the television cameras.

FIG. 23*b*.—Paul McGrath and Nancy Coleman in a scene from "Susan and God."

The object of the experiment was to ascertain whether or not the scene could be played before television cameras exactly as it was played in the Plymouth Theater. "No concession to television!" was the watchword. The results, as they were recorded by New York's theater and radio critics, indicated that Miss Lawrence and her supporters had succeeded in projecting

themselves very effectively, despite the fact that they did not cater to the new medium. The truth is, television played up to them. Camera operators, directors, and engineers coordinated their efforts and televised the proceedings with complete objectivity.

This experiment seems to disprove the contention that play material should be written for or specially adapted to television, but in reality it does not. Only one scene, completely isolated from a three-act drama, was involved. In televising that episode, it was learned that both the set and the live action on the set were too deep for the cameras; that is, it was difficult to follow the action intelligently and still keep the desirable elements in sharp focus.

So far as the script itself goes, there is no scene in "Susan and God" that does not lend itself to television. But if produced exclusively for the electronic medium, it would be advisable to redirect the play's action in order to keep it in sharp camera focus. This is definitely a concession to television, although in time, as the depth of focus of the camera improves, it should be possible to televise a play with depth of action greater than the dimensions of any modern stage.

In televising studio productions (or any other type of material for that matter), the director must keep in mind the small size of the picture at the receiver and the limitation of detail imposed by the number of lines present in the scanning pattern. Characters must be established by frequent close-up shots; and when facial expressions are important to the interpretation of the part, televised images must be large enough to carry the expressions clearly to the audience.

During the telecast of "The Missouri Legend," an intermission was bridged by the device of showing the face of a clock which marked the passing of 3 min. during the intermission. At the end of that period, a gong was sounded, as is common practice in the theater, to recall the attention of the members of the audience who might have left the room or engaged in conversation during the intermission period.

It appears, then, that although many plays can be televised without concessions, it is expedient in almost every case to rewrite, adapt, or alter dramatic material to suit television's needs. Generally, this adaptation work would seem to demand

less time, effort, and expense than the attempt to fit television to the dramatic material.

The "Susan and God" experiment gave many cause to wonder about careers as television actors. In these days of trial and experiment, the school of the theater is the salvation of television. Actors who have appeared in television say that the medium demands more imagination, energy, and talent than any other, requiring intensive application, quick and perfect memorizing of lines, and precise coordination of the mental faculties. Television affords actors a keen personal satisfaction and, in numerous instances observed, has enhanced the actor's part and technique in the same way the microphone enhances the human voice.

What the television producer seeks is photogenic personalities. This does not imply physical beauty but a face and body that appeal to the visual sense after passing through the interpretation of the television system. The body must move with rhythm and grace. The face should have interesting structural features. The personality should be positive and prepossessing, and, besides all this, the actor must know how to act.

The television actor's interpretation of a role should follow the ideas of a director who assumes the difficult job of visualizing the playwright's creation as a series of connected pictures. The television producer not only must interpret the playwright to the audience through stage management; he is also the central control and intelligence over all studio activities that contribute to launching a program into space. He becomes, in producing a television play, three individuals: a stage director, a movie director, and a radio director.

The program producer must, of course, shoulder the final responsibility for all matters that pertain to the program as it goes on the air. As in motion pictures and sound radio, however, the producer must avail himself of the assistance of the technical director, whose business it is to understand fully the limitations and capabilities of the technical equipment. The producer and the technical advisor, in fact, usually form a working team throughout the production of the program from its inception to its final presentation.

The collaboration between producer and technical director usually proceeds as follows:

1. The program content is chosen by members of the television program division, with the advice and suggestions of the television program board.
2. A producer is assigned to the program. He at once begins the preparation of the working script. In cooperation with the technical director, he works out the camera shots, lighting, action, and cues.
3. A cue sheet is then prepared from the producer's notes. This sheet shows the continuity for the entire program. Copies are distributed to everyone involved in the production of the program.
4. The actors and other performers are cast and assigned parts. Preliminary rehearsals are carried on outside the studio. But it is preferable to rehearse as soon as possible in the studio. In the early stages, no cameras or lights are employed.
5. The first camera "run-through" then follows, without lights, to establish the routine of the camera motions, etc.
6. The program is then rehearsed with lights and cameras. The producer takes his place before the monitor screens in the control room and works over each scene in the program until it is satisfactory from the audience point of view. During this rehearsal period, modifications of the original lighting schedule and camera routines are made where necessary. It is imperative that the performers, camera operators, microphone boom operator, and lighting technicians develop the knack of making such minor changes and remembering the final, satisfactory form for use in the final rehearsal and during the final presentation.
7. After several rehearsals (usually three or four) of the type just described, a dress rehearsal is held under as nearly "on-the-air" conditions as possible. The program is then ready for the audience.

This schedule of production and rehearsal has been developed over a long period and is designed to eliminate as much waste motion as possible. For example, such matters as the colors of costumes and scenery and make-up are decided by the producer, the technical director, and the art director before the performers are put into rehearsal. This eliminates much cut-and-try

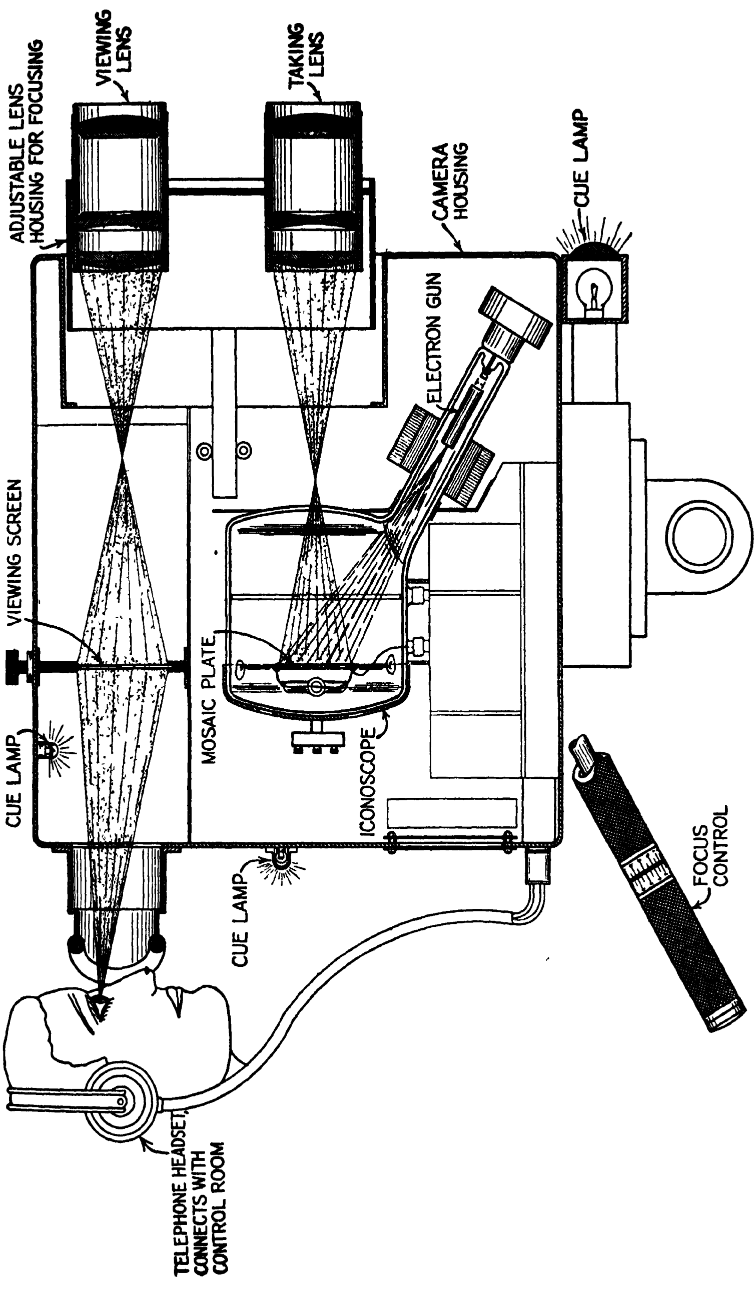


FIG. 24.—Cross-sectional diagram of a television camera used in studio productions.

effort. Also, the producer, in leaning on the technical director for purely technical matters, is free to concentrate on the artistic and dramatic content of the program. The advantage of rehearsing without lights in the early stages lies in the fact that

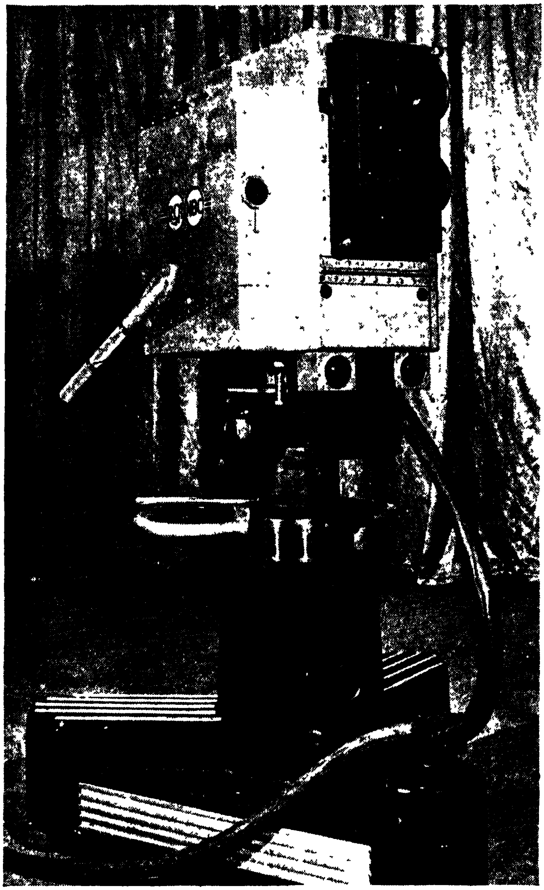


FIG. 25.—A studio-type television camera on a "pedestal." This type of camera may be operated and moved in and out of position by one man.

the studio personnel are then not subjected to the brightness and heat of the lighting system.

The first stage of production resembles the routine followed in the traditional theater. The play is studied and discussed by the ensemble. Subsequently, the producer "walks" or "breaks"

the play and molds each scene according to the motivation and plot. He finally sets its form and pace, never forgetting that studio action must be reassembled, in reduced size on the screen of the home receiver.

FIG. 26.—A "dolly" television camera. This camera is used for "moving shots"—such as moving in from a "long shot" of a person to a head-and-shoulders close-up. The camera operator can ride along with the camera, concentrating all his attention on the composition and focus of the picture, while being pushed by a second person.

In the second phase of production, the rehearsals take place before the television cameras in the studio. One camera is employed mainly for long-range operations. This camera is mounted on a "dolly" (a very flexible mobile mount, shown in

the illustration on page 71) and is maneuvered by an attendant. A second camera, mounted on a movable pedestal, is designed for close-range work, or close-ups. The third camera is used interchangeably with the other two; usually it is designated for close-ups. In front of each camera are two green lights, which indicate whether or not that particular camera is "on the air."

The producer strives to achieve a screen image that describes itself as television, or seeing at a distance; the instantaneous nature of the broadcast gives television drama a certain superiority over filmed drama. The spectator knows that he is seeing something actually taking place at the moment—not something that was recorded months before on a film and assembled in a cutting room. Television intimacy resembles a direct contact with the phase of life depicted on the screen. Consequently the illusion of reality gains fresh strength from television drama. The reaction of the public to this effect will define itself more clearly when sight broadcasting gains greater currency.

By his handling of the cameras, the producer can suggest space where there is none, compose pictures that conjure up states of mind, emphasize traits of character. The possibilities of imaginative camera direction are endless. Slovenly camera direction is apparent at once. It reveals itself by pointless emphasis, static images, and poor composition.

Skillful direction results in pictures that can convey the meaning and express the dramatic value of a scene without the aid of sound. Also, the transition from camera to camera is smooth—comparable to the effect of shifting one's gaze about a stage.

In the third phase of drama production, the producer leaves the studio proper and takes his place in the control room. In that post, he watches studio activities through the observation window while seeing the television images on the monitor screens and hearing the reproduced voices. At this stage he also coordinates the efforts of the actors, engineers, and special-effects men into a program suitable for transmission.

Flanked by sight and sound engineers, the producer watches the cast go through its rehearsals, calling halts when he wants to make changes or suggestions over a speaker system that carries his voice into the studio. By observing the screen images, he verifies or alters the camera cues on the script. As the production shapes itself into final form, he appraises the general effect on

the monitor screens. Simultaneously he cues the camera number, cues the position of the next shot, previews it, and gives switching orders. Also, he maintains direct ear-phone contact with the studio manager, who passes along instruction to the actors and attendants. Despite the attention he must devote to technical operations, the producer must ever be conscious of a play's aesthetic and emotional values.

When the studio rehearsal periods end, the collective efforts of staff and cast reach a climax in the broadcast, the producer

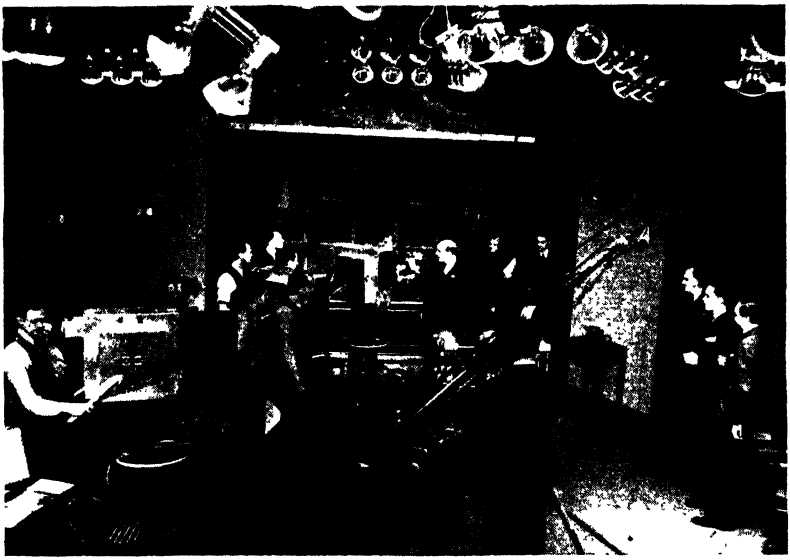


FIG. 27.—Studio technical personnel and actors receiving instructions from the program producer (immediately to right of center camera) during a rehearsal of a dramatic presentation.

remaining at the control console where he conducts the performance as the program radiates into space.

In the control room the technical director, in addition to switching from camera to camera on cues from the program producer, has many other important responsibilities. He must help the camera men, through telephonic communication, to obtain the proper picture composition as called for in the producer's script and to check on camera focusing. The technical director supervises and coordinates the work of the video and audio engineers; he shoulders the responsibility of obtaining the

best possible technical picture quality. Lighting must also be checked and coordinated with the various camera shots. When film or outside pickups are an integral part of the studio program, or if either film or outside pickups immediately precede or follow the studio portion of a broadcast, it is the technical director's responsibility to handle the switching to and from the studio and to issue the necessary "warning" and "take-it-away" cues to the studio personnel. Finally, the technical director is responsible for matters of safety in the studio.

Inexpensive variety acts are generally composed of entertainers whose repertoire is limited. Once they exhaust the possibilities of one act, it may take them considerable time to prepare another. The more prominent vaudeville entertainers naturally demand and get high fees, which television may be unable to pay for some years.

In NBC's experience with variety entertainment, we have found it most difficult to project humor. Recognized and accomplished "gag" writers and comedians find lucrative employment in both the moving-picture field and sound broadcasting. Until it reaches the stage of commercial sponsorship, television cannot hope to compete for their services.

Vaudeville artists have been trained around the custom of timing their gags to audience reaction. Since television cannot at present accommodate studio audiences, the program producer has, on occasion, adopted the subterfuge of presenting variety entertainment from a cabaret set where an audience sits around tables and provides the equivalent of an audience reaction.

In general, informative material falls into the following classifications:

Illustrated news commentation.
Instruction in various techniques.
Discussion of the arts and sciences.
Illustrated historical reviews.
Travelogues and documentary descriptive films.

Each classification may further be broken down into large numbers of program subjects. Such material has contributed much to the success of sound radio, but introduction of long verbal dissertations soon tires the most patient listener. Tele-

vision promises to offset this serious handicap to a large extent, because it broadcasts animated pictures that illustrate ideas more rapidly and effectively than words.

Great interest is being shown by motion-picture audiences in documentary shorts presented in the form of popular science demonstrations, travelogues, or illustrations of believe-it-or-not facts. Through moving pictures and slides, visual education has become part of the curriculum in many schools, because of the superior effectiveness of visual over verbal descriptions.

In attempting to illustrate radio news with pictures, we are prone to follow the technique developed by such news magazines as *Life*, *The Illustrated London News*, and *L'Illustration*. It is not necessary to illustrate news with moving pictures, for in many cases movie reels are unavailable on short notice. But we do have access to photographs filed by news photograph agencies or to the product of free-lance photographers. In order to facilitate the preparation of a program on short notice, it has been advisable to build up a special still-photograph and document library, or "morgue," one section of which is devoted to maps, charts, and airplane views.

The use of moving pictures in connection with a news broadcast would of course render an illustrated radio news service more vital. To assure a constant supply of fresh film for this purpose, television may eventually require a far-flung organization of correspondent-cinephotographers. In metropolitan areas such as New York, Chicago, San Francisco, and Philadelphia, it may in the future also be advisable to maintain a staff of newsreel camera operators serving under a general editor who would assign them to "cover" events in the news especially for television.

In the ultimate development of an illustrated radio news service, television might build up a world-wide organization to relay spot-news photographs by radio or wire. As these are transmitted through the television system, a speaker or announcer could make appropriate comment. Pictorial-news broadcasting may in time become one of television's most important public service functions. For here the program staff has at its disposal the means of depicting history exactly as it takes place. No matter if a news broadcast is unrehearsed or even if it appears amateurish, the ingredients of drama and interest are present to a large degree.

Pictorial-news broadcasting greatly simplifies the problem of programing, since many dramatic events can be televised without engaging actors, writers, scene designers, or musicians. The interest shown in several sidewalk interviews arranged for television broadcasting indicates that the televiewers' interest in Vox Pop programs can be taken for granted.

Wide publicity was given to the efforts of the British Broadcasting Corporation in televising the coronation of King George VI. The use of this historic event as program material presages many similar sight broadcasts in the future. We can always count on more live interest in current than in past history; and fortunately for television, it is infinitely simpler to televise current history than history recorded in books.

In this connection, it is interesting to note that televiewers in England were clamoring for more and better illustrated news broadcasts. Public interest had been stirred by the coronation sight broadcast and by those of sports events and pageants.

In a metropolis like New York or in a capitol like Washington, it is possible to arrange special news events in advance for television. The proceedings of conventions, parades, strikes, fires, disasters, etc., may be broadcast, though spot news will be difficult to handle except by chance until some time in the far future, when transmission is running on as full a schedule as that of sound broadcasting today.

The televising of public events has occupied a considerable portion of the time devoted by NBC to outside broadcasts. The first of these programs was the opening of the New York World's Fair, during which the ceremonies were televised in full, including the dedication address by President Roosevelt. Later, when the King and Queen of England visited the fair on their visit to the United States, mobile television units were set up in the Court of Peace and succeeded in televising the entire proceedings. This program was received, using a special antenna on a high elevation, 130 miles away near Albany, N. Y. The 1939 Memorial Day parade, another outside event of general public interest, was picked up by the television trucks at Seventy-second Street and Riverside Drive, New York. The program, one of the longest devoted to a single locale, lasted nearly 3 hr., and reports from members of the audience indicate definitely that the interest was maintained throughout that time.

Giving instruction of various kinds to students or to the public at large appears to be a fruitful source of program material. With the cooperation of Dr. C. C. Clark of New York University, NBC broadcast a demonstration and description of the photoelectric cell. The program was projected before several audiences. Each time it was produced, improvements were made. It was plain that a complicated device like the photo-

FIG. 28.—New York University students watching a televised lecture-demonstration on the principles of photoelectricity. The students, through a talk-back circuit, were able to ask the lecturer questions just as in the classroom.

electric cell could be explained in such a way as to hold attention and make the subject entirely clear.

NBC also has experimented with various types of athletic instruction. A professional playing golf has been televised. The technique of fencing has been demonstrated by several well-known fencers. Dancing lessons have proved to be particularly well suited to television.

Experimental programs demonstrating various "how-to-do" techniques have been broadcast. Instruction in how-to-do permits the use of outdoor pickups to a large extent. For instance, it is comparatively simple to televise phases of gardening, house

building, painting, etc. This material could be picked up with the mobile unit, or, if there were access to a large outdoor area at the studio plant, the pickup could be arranged with the regular studio equipment. Demonstrations of home workshop technique, bookbinding, and similar hobbies should make interesting program material.

Demonstrations of laboratory and natural processes afford still another promising source of program material. Such programs

FIG. 29.—A book-review broadcast. While the commentator was turning pages, switches were made to close-ups of the various illustrations before another camera.

may prove especially valuable to commercial sponsors who want to avoid long discussions of their products. By various visual devices the products can be illustrated to the television audience in a way to stimulate sales.

Cooking lessons have proved popular at community houses and neighborhood settlements, and probably they can be employed to good advantage in television. The culinary art has achieved an incredible popularity on sound radio. Tele-

vision programs of cooking lessons have proved interesting, at least to housewives. One such program was built around the arrival of an unexpected guest, illustrating how a meal was quickly prepared from what was on the pantry shelves.

At certain hours of the day, music lessons can attract many televiewers. Such lessons are infinitely more practical on television than on sound radio, for on television it is possible to reveal the fine points of fingering keys or strings.

The public may be disposed to lend ears and eyes to criticisms and reviews of productions in the arts and sciences. An illustrated book review, in which the nature or contents of a book is presented by an able critic, correlating words with pictures; reviews of current films or theater presentations and art exhibits can be broadcast as television programs.

During the summer months of 1939, NBC televised a series of noonday broadcasts composed partly of film presentations and partly of simple studio material. A goodly part of the studio time was taken up by educational and informative subjects, ranging from the etiquette of cigarette smoking to instruction for fathers on the bathing of babies. Unusual musical instruments, such as the harpsichord and several Chinese stringed instruments, were demonstrated by internationally known performers.

With pictures of geologic strata or historic ruins and similar residues of past centuries, it would be possible to televise events leading up to present-day conditions and customs. Human habitations in foreign lands, the burial grounds of ancient peoples, the sacred documents preserved in museums, samples of handiwork and art by vanished civilizations—all these could be used in reviewing the march of mankind. A considerable amount of travelogue film is used at present from travel agencies, transportation companies, government offices, and other sources.

The treatment of documentary subjects by March of Time films is definitely adaptable to television. Certainly the method and procedure deserve close consideration. There is also a possibility of creating descriptive films to order in a television studio plant, by joining new film to studio shots or to sequences borrowed from the film library.

The use of silent film is no bar to producing an arresting and provocative documentary program. The accompanying dis-

cussion or commentary can be worked in by a commentator in the studio as the film story is projected.

This technique was very successfully employed in several Explorers' Club programs. A prominent explorer and several colleagues were first introduced to the television audience seated around a table "swapping yarns." The men took no notice of the presence of the camera, and the audience was given the impression of looking in on a get-together at the Explorers' Club. The host of the group then offered to show some of his films to illustrate the point of his conversation. At that point, the cameras were switched to the film studio, and the film in question was put on the air. Meanwhile, the men in the gathering carried on their conversation, which was then directed toward the film. The host pointed out scenes of unusual interest and answered the questions of his guests as he went along. This is an educational technique which, so far as is known to the writer, is wholly new, and one which would hardly be possible without the special attributes of the television medium.

This latter type of informative program was also experimentally presented with movie film by a staff lecturer of the Metropolitan Museum of Art. His picture and accompanying lecture compared ancient agricultural methods in the Nile Valley to those currently used, and he demonstrated that in the past 3,000 years Egyptian agricultural methods have changed very little. The film was silent, and the narration was ad libbed by the lecturer as the film was exhibited.

Either of two methods for broadcasting athletic and sports events may be employed, both having rich possibilities. The telemobile unit has visited sports stadiums, parks, and water fronts and televised actual games and contests.

The huge scale of outdoor and indoor sports events in America prompts the belief that television broadcasters will experience less difficulty in acquiring television rights than foreign broadcasters appear to have had. In the New York metropolitan area, numerous scheduled sports events have made excellent material for television programs. Among them are baseball games, tennis matches, track and field meets skating events, bicycle races, and swimming meets.

When ample-sized studios are built, or when grounds adjacent to the studio plant are available, it should be possible to stage

athletic and sports events especially for television at an overhead expense considerably less than is necessary for similar events managed by commercial promoters.

Numerous feats of athletic prowess such as weight lifting, wrestling, tugs of war, calisthenics, body building, and high diving might conveniently be brought into a television plant, which sooner or later would acquire its own swimming pool and studio gymnasium as well as outdoor stadium.

Various athletic groups and associations might be interested in forming amateur sports leagues whose games and contests could be televised for local consumption. This would provide a good source for run-of-the-mine television program material, while building a neighborhood interest in purchasing television receivers.

Aside from the athletic events involving physical strength and prowess, there is a possibility of arranging local and national contests in parlor games, such as bridge, chess, and question bees. Studio experiments indicate that interesting programs can be built around fencing, bowling, wrestling, and boxing. Further experiments are going forward with these and other sports.

Since the inauguration of public television service, NBC has televised a variety of sporting events from outside locations. Among the first was a baseball game between Princeton and Columbia universities, which was picked up by the mobile units at Baker Field, New York, and relayed by radio to the Empire State transmitter. Later, a portion of the six-day bicycle races at Madison Square Garden was televised, under somewhat unusual conditions. The broadcast was at night, and the lighting used was provided by standard fixtures already present in the arena. The mobile units were driven into the basement of the Garden, and camera cables connected with the camera located beside the track. To connect the mobile units with the Empire State transmitter, two connecting links were used. The first was an ordinary telephone circuit, specially equipped with equalizers and amplifiers to enable the picture signal to be transmitted without distortion to the studios at Radio City, about one mile distant from the arena. Telephone circuits can now be adapted for transmitting picture signals, provided the circuit is not too long (not longer than a few miles). From Radio City the program was again relayed, via the conventional coaxial

cable circuit, to the Empire State Building, where it was put on the air. The use of the telephone circuit was heralded as a milestone in remote pickup practice, since it permits much more flexibility in picking up broadcasts from points not served by coaxial cable. The Baer-Nova prize fight was successfully telecast on June 1, 1939, from the Yankee Stadium.

Outside broadcasts of a somewhat different nature have been produced in connection with parades and other ceremonial occa-

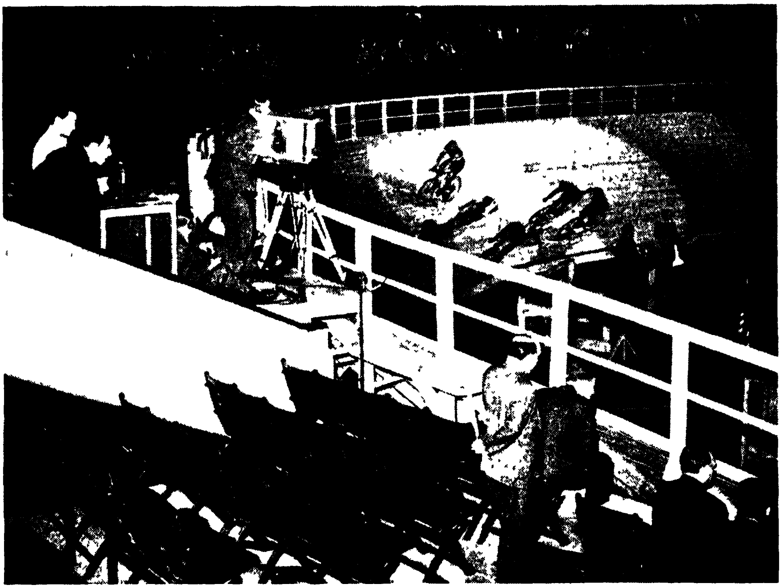


FIG. 30.—The television camera setup at the six-day bicycle race at Madison Square Garden.

sions. Besides those already mentioned, a variety of pickup broadcasts from the New York World's Fair have also been presented, notably special occasions such as Pan-American day ceremonies, and various novelties such as the Sun Valley Lodge and Frank Buck's Jungle Camp.

The popular assumption that television will be devoted chiefly to the drama or to other live-talent performances is scarcely correct. If we weigh the entertainment value of program material that principally employs *actors* to achieve the desired effects, we are compelled to admit that the histrionic art, as we know it today, can occupy but a portion of television's bill of fare.

Supplementing histrionics, we can introduce innumerable mechanical devices to achieve program variety. Puppetry, for example, has reached a state of development where good adult and juvenile entertainment can be created before the camera. Puppet shows permit the broadcaster to transmit abstract and imaginative ideas that cannot be handled satisfactorily by human actors. The figurines can be made to caricature historical personalities or personality types; they can satirize current events with a wit that would be subject to criticism if presented by human beings.

The universal popularity of comic strips and comic-strip personalities leads to the belief that characters can be created that will be as endearing and as human as Tillie the Toiler, Popeye, and Little Orphan Annie. For juvenile entertainment, the serialized puppet show could be made to follow the daily monkeyshines of newspaper comic-strip characters.

Television may not only adopt current comic-strip characters; it can invent and establish personalities whose popularity may compare with even Mickey Mouse or Donald Duck. Such fantasies as "Gulliver's Travels," "Alice in Wonderland," and "The Arabian Nights" can be visualized; or fiction like "Twenty Thousand Leagues under the Sea," "Tarzan of the Apes," and "The Men on the Moon."

In some respects, the broadcast puppet show may turn out to be the television equivalent of the animated cartoon. We can scarcely hope to obtain exhibition rights to Hollywood's film cartoons, since they involve enormous outlays. Animated film production is an arduous and costly process. Approximately 100 people work 2 weeks to produce an 8-min. film cartoon, and the cost amounts to about $2,100 per minute of projection time. The puppet show should prove capable of adaptation and elaboration in the new medium at comparatively modest expense.

Another device that is useful to television programers is the scale model. When necessary to show a general view of a landscape to reveal certain facts or relationships necessary to a story, it has been found practicable to build a model, manually or mechanically operated, that answers the purpose very well. Such models resemble miniature stages in three dimensions.

Scale enlargements of miniature devices also have demonstrated a usefulness in television. For example, in explaining

the photoelectric cell, it was found difficult to show the small parts inside the tube; scale models three or four times larger than the originals were successfully exhibited.

Besides dolls and models, certain scientific instruments, machines, and specialized devices that the layman rarely sees have been introduced in television.

New and fascinating program material can be brought to light by the modern projection microscope. Through high-powered

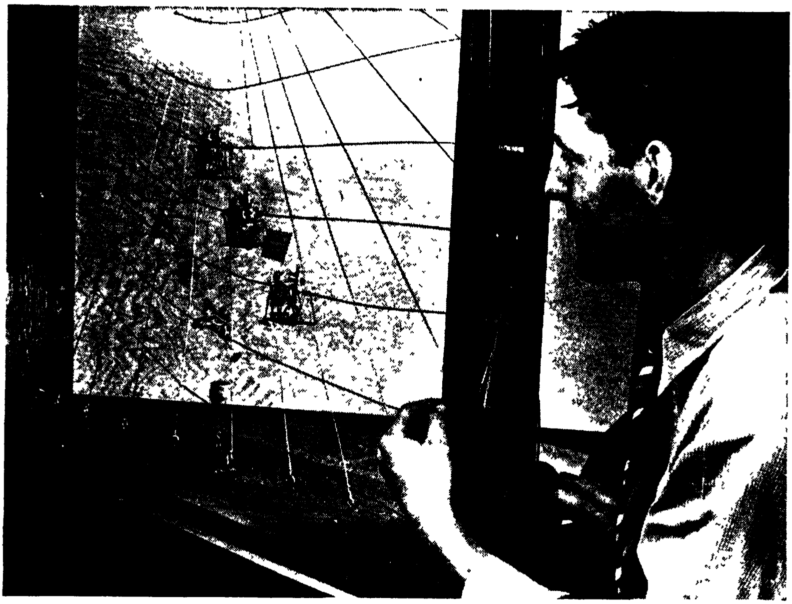


FIG. 31.—Example of sight effects constructed for a fairy-story presentation, requiring animated spiders spinning a web.

magnification, television can reveal the life cycles of organisms invisible to the naked eye; it can demonstrate numerous processes or optically dissect common materials and in numerous other ways enlarge the breadth and scope of popular knowledge.

Through the telescope, television might introduce program material borrowed from the theater of the universe. Remote distances, perhaps millions of light years, can be compressed into the limited dimensions of the television screen. The drama of the cosmos illustrated in modern planetariums can be brought into the home and observed at the family fireside. Eclipses,

solar storms, sunspots, and the relative grouping of stars and planets can be broadcast effectively.

Technical devices and contrivances can be brought before the television camera, and they may either be demonstrated or employed incidentally. Commercial sponsors may use thermometers, bunsen burners, stroboscopes, adding machines, lathes, or optical devices to depict the superiority of their products.

"Synthetic ballets" composed of cubistic, geometric, and other forms may be presented through the medium of various combinations of light and lenses. Such mobile patterns might be presented as "black-outs" or as transitional material to sustain interest during intermissions or interruptions. The recent success of movie shorts built around synthetic ballets indicates that this device may have promise in television, and its possibilities are now being explored.

Certain program material appears unsuitable for television if presented in the conventional manner. For example, we have discovered that even a fast-moving, frisky animal act cannot sustain interest more than a few minutes. In a recent program, a trained-dog act was televised. The camera operators found it difficult to follow the animals' tricks without constant "panning"—as objectionable in television as in the movies. Because of imperfect resolution, the dogs' performance could not be followed easily when the wide-angle lens was used on the camera; when camera close-ups were substituted, the animals constantly jumped out of the field of vision.

One type of entertainment that has proved difficult is sleight of hand. People are familiar with Hollywood tricks involving double exposure, background projection, and the use of doubles. Partially because of this familiarity, sleight of hand appears to televiewers as a photographic trick rather than a visual deception. With fast-moving card tricks, camera operators have found it difficult to photograph the high-speed movements of magicians from interesting angles. If one hand is allowed to get out of the camera's field of vision, the result to the televiewer is annoyance.

As television spreads it will be necessary to increase space for property and scenery shops. The simplest expedient is to provide adequate construction space outside the studio but adjacent

to it. Dressing rooms should be as near the studio as possible, to expedite costume changes during broadcasts. It may be practicable to facilitate changes by providing collapsible dressing rooms which can be set up at convenient places in the studio.

The limitations of the present television-studio facilities have made it rather difficult to follow a systematic procedure for scene shifting during a broadcast. In television, there are no breaks or intermissions. During the course of a production, the microphone is sensitive to extraneous sounds, and therefore it is necessary to arrange all sets and props before the producer gives the go-ahead signal and to move them as silently as possible.

Since most scenes are used but once and then repainted or rebuilt, set construction is inexpensive. The elaborate and realistic sets of Hollywood are at present beyond the means of television. It is difficult to forecast how elaborate settings will be in commercial television shows. At any rate, we feel that any new studio plant should provide areas free from obstructions, so as to allow for the building, erection, and storage of elaborate scenes.

NBC has experimented with background projection as a scenic device. Thus far, still pictures only have been used. The present equipment consists of a high-powered projector located in a projection room at one end of the studio. A slide is inserted between the light source and the magnifying lens of the apparatus, and the picture is projected on a translucent screen in the studio.

It is impracticable to utilize projection distances of more than 15 or 20 ft., because of present studio space limitations. Thus far, background pictures have been projected photographs of outdoor scenes as viewed through a door or window.

The production of dramatic material for television broadcasting is a matter that depends almost entirely on the experience and imagination of the producer and his associates. It is difficult to establish definite rules for successful production, since each script demands different treatment and since the camera technique differs greatly with the number of camera chains installed, the layout of the studio, the available floor area, and many other factors. Under the circumstances, it seems desirable to illustrate dramatic production for television in terms of a typical playing script, including the camera action and switching cues.

The complete script of "The Three Garridebs," a Sherlock Holmes mystery drama, is given in the Appendix (page 225).

"The Three Garridebs" was presented during the field tests of the NBC system prior to the beginning of public service. At that time, only two camera chains were installed, whereas three have been available since Apr. 30, 1939. The restriction of camera flexibility had its effect on the presentation of the play; but aside from this difference, the treatment is quite typical of

FIG. 32.—A scene in Sherlock Holmes' living room in televised version of "The Three Garridebs."

present practice. At the time it was given, it represented the best efforts of the production staff and afforded opportunity of testing many dramatic effects and techniques.

The playing script is difficult to read, even for those versed in dramatics, unless certain suggestions are followed. In the first place, the script should be read through once, and preferably twice, for the plot and lines alone. In this preliminary reading, the details of studio layout, camera action, and cues should be disregarded entirely. Then, with the story and routine of the

play well in mind, the figures should be studied to determine the manner in which the various sets and properties have been arranged in the studio. Next, the script should be read with the purpose of following the camera action. In this reading, primary attention should be paid to the camera instructions that follow each switching cue. By the time the next switching cue appears, these instructions have been followed, and the reader must bear in mind the position that each camera has taken before the next switch occurs. The diagrams may aid in following several examples of camera movement. Finally, the cues and camera action may be examined more closely to determine the purpose behind each shift of scene, *i.e.*, the establishment of location and character, maintenance of tempo, etc. A few cases noted in footnotes will be found where the technical limitations determined the camera action; but for the most part, the switches have been set by the producer arbitrarily, for dramatic effect, rather than in answer to technical limitations.

In following the camera action, it must be borne in mind that the two cameras are fitted with different lenses. Camera 1 has a wide-angle lens, capable of taking in an angle of about 37 deg. (in a horizontal plane), and is used for taking shots of a whole scene or group of actors. This camera is mounted on a "dolly" which permits operation of the camera in motion—as when coming from a distant shot to a close-up. Camera 2 has a narrow-angle lens and is used principally for close-up work, covering an angle of about 13 deg. This camera works farther from the subject than camera 1 and, although readily movable, is not intended for operation when in motion. The relationship between these lens characteristics and the camera instructions must of course be taken into account in reading the script as printed in the Appendix.

CHAPTER VI

MOTION-PICTURE FILM PROGRAMS

Motion-picture film should take an important place in television programing. Film used in television has all the advantages that it does in motion-picture theaters and certain additional uses. It usually has high technical quality, and the material is permanently recorded for use at will. From the economic aspect, it would appear advantageous to use a projector, a pickup Iconoscope camera, two engineers, and a projectionist instead of the large crew of actors, directors, and engineers required for a live-talent studio production or for the mobile unit in the field.

Film serves also as the means of syndicating production, so that a single program may be broadcast simultaneously or successively from widely scattered stations.

Film also serves to record features such as news, educational material, and other subject matter that can be presented as programs by themselves. In addition to these uses, film in television serves a highly important function in bridging unavoidable pauses during the production of a program that is predominantly live talent. In televising "The Three Garridebs," for instance, the production staff found it necessary to indicate outdoor action. Obviously, it was impossible to take cameras at that moment to, say, Central Park and televise Sherlock Holmes and Dr. Watson in a hansom. So a film record showing the actors properly attired was prepared in advance, sound added, and the sequence run off at the proper time between two scenes in the live-talent studios. The transition was effected so smoothly that persons witnessing the performance were not aware of the interpolated strip of motion picture. Here is a highly important use of film that does not appear in any other medium of entertainment.

When film is used, the technical-operating costs are sharply reduced. Directors, actors, and rehearsals are dispensed with. The lighting expert, scenic designer, property men, studio sound

men, and all but the equivalent of one camera operator are also absent from the motion-picture projection studio. Finally, after the film has been run off, it may be returned to storage vaults for rerun at a future date. All this, of course, becomes possible in television because the various operations of preparing the film were previously carried out at the motion-picture studio in the production of the film.

For this reason, the economic advantage of film in television is realized only when the film itself can be obtained at low cost from the production company. If the full costs of producing the film especially for television are considered, then it is found that the production of a live-talent studio film is cheaper, by a wide margin, than the equivalent film would be. Nevertheless, film prepared especially for television may eventually prove to be an important item, if only for the reasons that such film may be stored for re-use at a later time and that the film may be shipped from station to station to permit showing the program to a larger audience than one station could cover. This method of syndication would reduce the cost per program-hour by permitting the showing of the same program either simultaneously or successively in many different cities.

At present, the only films produced by the National Broadcasting Company especially for television have been short subjects entitled "Teletopics." These are silent films recorded, for the most part, with a portable 35-mm. camera. The sound channel is "dubbed" in during the broadcast of the film by an announcer who reads the description into a microphone as the film progresses and by the use of phonograph records for musical effects. These programs, which have been popular with the audience, have covered a wide variety of subjects, from demonstrations of sporting goods to travelogues. The cost of producing the film is very low indeed, judged by Hollywood standards, and it serves very well for short presentations as part of a variety hour.

Broadcasters do not expect that motion-picture producers will permit the use of their first-run feature pictures or, in fact, even their shorts and newsreels, since, when there is a substantial circulation, television would show the picture to so many people as to affect adversely the box-office receipts not only of the major but also of the neighborhood houses as well. It is not incon-

ceivable that, as and when the television audience justifies it, films may be produced by the movies, built especially for television.

The use of television to help exploit important pictures in the theater is already being given consideration by the motion-picture interests. A glorified trailer similar to those used in the theater at previews, but amplified to provide some real entertainment, can attract attention to worth-while feature pictures, and it is probable that many major producers will avail themselves of the television medium for this purpose. Special trailers can be constructed from the original footage. "Gunga Din" was so treated for the television audience.

The moving-picture business and television have much in common and can mutually profit by cooperation and understanding of each other's problems; dissimilar as they are, they have many factors in common offering opportunities for mutual profit and technical advancement.

Most moving pictures several years old that have completed their rounds of all the neighborhood theaters do not make particularly good television material, because such a large number of persons have already seen the picture. Also, the yearly technical improvements in motion pictures and the changes in costumes and mannerisms give these pictures more of an historical than an entertainment interest.

Newsreels present an excellent form of television entertainment, but there is the same difficulty in obtaining current newsreels as in obtaining feature films. Since, eventually, television could put newsreels on the air and display them to a wide audience before they could be seen in the theaters, it would definitely impair their value for the exhibitors. If newsreels are to be used in television, the broadcasters may be forced to organize newsreel companies of their own or contract with existing companies to produce films especially for their use. This would be desirable in any case because of the different technique required in taking pictures for television and in taking them for the movies. Several crews might be stationed in various parts of the country, as is the current practice with the newsreel companies of today, but, in addition, news crews might be continuously taking shots of local personalities and of places of interest for filing with the local television station for use from

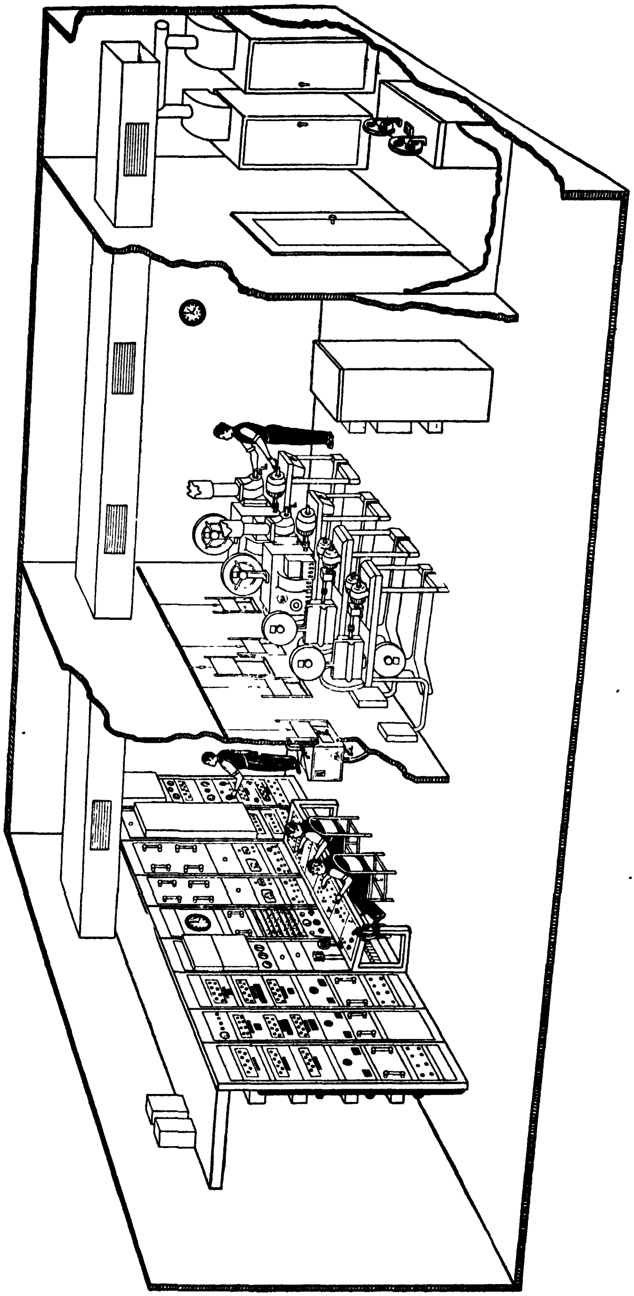


FIG. 33.—The projection studio at Radio City. From left to right, control room, projector room, and film vault and editing room.

time to time as fill-ins or to patch together quickly to illustrate a news event that has just happened. It is conceivable that within 30 min. after a news event of importance was flashed over the teletype, the station could be on the air with a telecast showing pictures both recent and past of the personalities involved and the scenes of places that figured in the instance, the sound portion being composed of those sound tracks on the film which were applicable and the rest being ad libbed by a commentator giving the high lights of the news.

There is considerable discussion in the motion-picture industry as to ways in which television could be used to further distribution of films and to increase the rapidity of capital turnover. A feature picture for domestic and foreign distribution requires 18 months to earn its cost, plus a profit. It is conceivable, therefore, that after the first and second runs of a feature picture have been taken, the third and fourth runs might be taken on a nation-wide television hookup, speeding up the capital turnover on the film to about 6 months or even less. In these cases, it might be desirable to edit a feature especially for such distribution.

The projection studio at Radio City (see Fig. 33, page 92) is housed in two adjoining rooms. The first contains four motion-picture projectors, a stereoptican for lantern slides, and the sound pickup equipment. Two of the projectors are of the standard type with sound heads for 35-mm. film. The two 16-mm. projectors may be used with either silent or sound films.

The 35-mm. machines were built to operate at the standard rate of 24 frames (or pictures) a second. Since the system of television stipulates 30 complete pictures a second, the projectors are equipped with a most ingenious mechanism that bridges the discrepancy. Were such a device unavailable, the wealth of entertainment on standard film could not be used, since operation at 30 frames would distort action and sound far beyond reasonable tolerances. The 16-mm. machines are also provided with special frame-compensating devices.

Any type of film may be used on television, including the 35-, 16-, and 8-mm. forms. It can be silent or sound film, run at a rate of either 24 or 16 frames per second, in black and white or in color. Each finds some usefulness.

Power requirements of this equipment make necessary the use of oversize driving motors of the synchronous type, in order to

keep the projection in step with the television system. To this end, the motors are supplied from the alternating-current source that feeds the sight-synchronizing apparatus. Each projector, instead of casting a beam on a screen as in theaters, operates through a window in the wall that separates the projection booth from the control room. The projection lens focuses the film image directly on the plate of an Iconoscope tube encased in

FIG. 34.—The film-projector room at Radio City. The two large projectors are for 35-mm. film, and the small projector in foreground is for 16-mm. film.

a camera, set at a distance of 12 to 18 in. away. Two cameras are so mounted on a track that they can be moved into place in front of any projector quickly and accurately.

At the control desk are adjustments for Iconoscope electrical focusing; camera-switching push buttons; motor and framing controls for the projectors; contrast, brightness, and shading controls. One engineer devotes his time to correcting imperfections in the shading of the various sections of the image; the other is in charge of over-all control, including the general illumi-

nation of the image, sound, and projector control, and so on. From this control desk, where the image is monitored, the impulses representing the motion picture are passed on to equip-

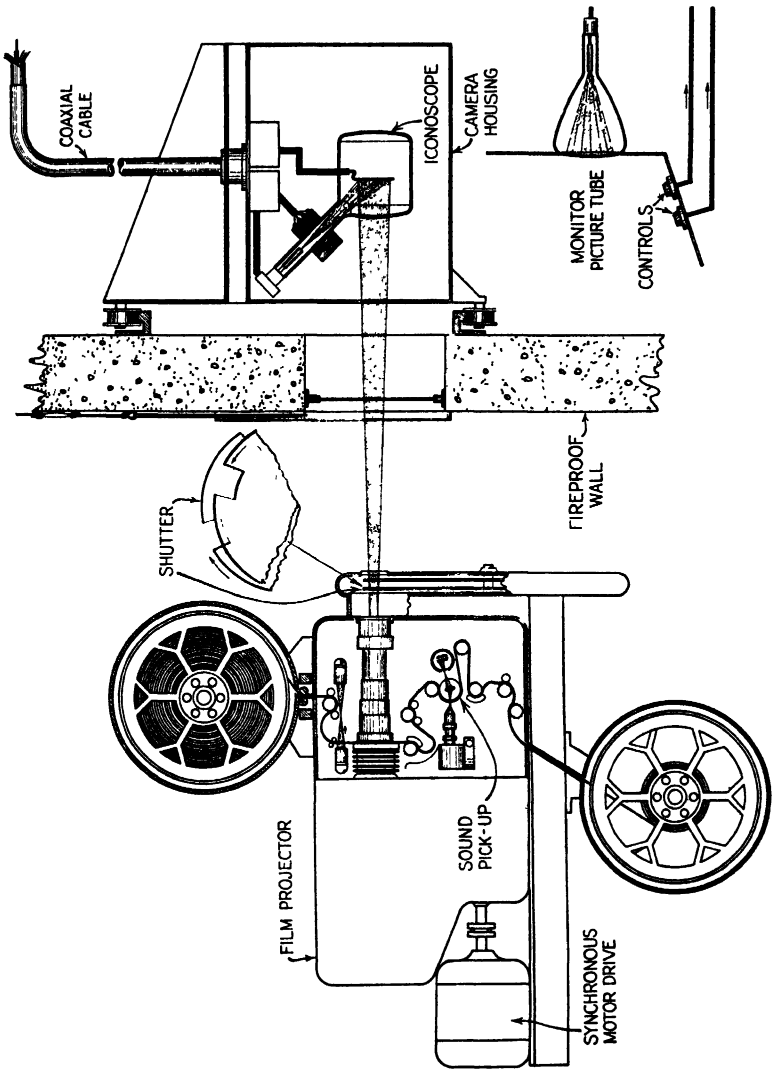


FIG. 35.—Cross section of motion-picture projector and television camera used in the televising of film.

ment where synchronizing and control impulses are added, and the whole amplified for transmission to the Empire State tower transmitter.

During the summer months of 1939, the program schedule called for one to three full-length feature films each week. Among those shown to the audience were several older American feature films, some of which had no doubt been seen previously

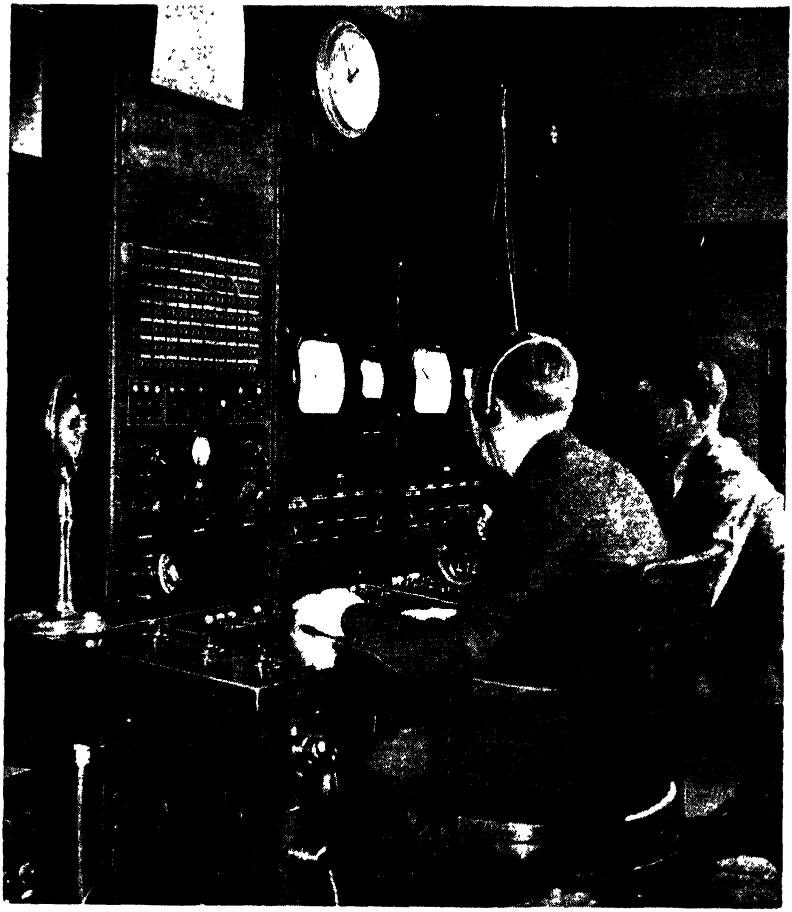


FIG. 36.—The control room of the film-projection studio at Radio City.

by most of the audience in movie theaters but which were enjoyed as "revivals." An especially fine presentation of this type was the showing of "Hell's Angels," one of the most popular pictures ever filmed. The great length of this film and the problem of budgeting its rental cost made it necessary to

show it in two parts, on successive nights. The audience reacted very positively to this type of entertainment and method of presentation, despite the fact that the film was originally made some 5 years before its showing on the television system. Other feature-length films that found favor with the audience were the "documentary" films showing native life in various portions of the world. Among these were "The Adventures of Chico," "The Wave," which depict peasant life in Mexico; and "The Edge of the World," whose locale is the primitive outer islands off the Scottish coast. Among the foreign-language films, one of the most popular was "Carnival in Flanders," which had found an enthusiastic reception in American theaters in 1936. A liberal number of lesser films, including mystery dramas, Western thrillers, and semihistorical films were also shown.

During the noonday broadcasts of the same period, the schedule called for ½ hr. of film 4 days a week. This film was of the "short" variety, usually two 15-min. subjects to the program. It was obtained from various sources, including the American Red Cross, various government departments, and other civic organizations, as well as from travel agencies and industrial concerns. The audience reaction to this material seemed to be somewhat lower than that to the live-talent presentations that immediately preceded and followed it, but the better films were nevertheless very well received.

An important consideration in weighing the relative merits of live-talent and film programs is the quality of the sound reproduction in the two cases: owing to the wide band and the absence of natural static on the high frequencies used in television, and the fact that its fidelity is not limited by long telephone lines, the sound from live-talent programs emerges from the receiver with an amazing crispness, clarity, and fidelity. Even on the best of 35-mm. film, the sound is not quite so good as that from the studio; and on the poorer or older film, it is definitely worse.

In the experiments at Radio City with practically every kind of film—full-length features, shorts, newsreels, educational films, industrial shorts, and documentary films—it has been found that the use of film in television is complicated by a quite serious psychological problem. Motion-picture films are edited with an assembled audience in mind. Audience reaction in a crowded

theater differs considerably from that of a small home audience.

In the motion-picture house, emotional peaks are longer in building up and longer in disappearing than is the case with a group where only two or three are gathered together. The emotions of sympathy, joy, grief, anger, and so on are infectious. Every large crowd contains some persons whose ready reaction immediately touches off sympathetic reactions in their neighbors, others whose emotional responses prolong the average reaction. Action that would be applauded by a packed house falls flat in a sparsely filled movie theater.

Television must contend with that problem. The home audience is both quicker in building up its reaction and quicker in passing through it than is the larger theater audience. Films ideally adapted for the theater may be less suitable for the home audience. Newsreels have proved to be the most satisfactory of commercial films. The "March of Time" films, with their calculated emotional peaks and dramatic sound sequences, likewise have been successful when televised but less so than when shown in a motion-picture theater. Such a feature film as "The Return of the Scarlet Pimpernel," even as successful as it was in the theater, definitely dragged when it was seen in the television receiver.

These considerations appear to indicate that film will be of most value in the shorter productions. Here the advantage of their employment is incalculable. A "short," running perhaps 10 min., affords the opportunity of breaking up an hour's television program into live-talent productions and film productions and film presentations. By careful sandwiching of film between live-talent acts, the production staff is enabled to clear scenes and props in the live-talent studio for new acts, avoiding pauses in the performance.

It would appear on first thought that television can depend upon standard moving-picture production for sufficient program material to maintain daily schedules approximating those of sound broadcasting. This conclusion is erroneous. A single television transmitter can absorb more program material than can be provided by the combined cinema establishments of the world.

The Motion Picture Section of the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, estimates

that if every foot of assembled negative produced in the United States or imported into this country from abroad were available for broadcasting, it would provide but 3 hr. of television program service daily. The capital investment in American film-studio facilities alone is approximately $100,000,000. The film rentals paid by exhibitors for use of the film produced amount each year to about $250,000,000.

Until the new medium attains a wide circulation, it does not seem economically possible to make moving pictures exclusively for broadcasting, even if ways of reducing Hollywood costs can be discovered. The least expensive drama turned out in Hollywood costs about $250 per minute of projection time, but the major portion of film produced costs from $1,000 to $3,000 per minute of projection time, and some productions cost much more than this. The average photoplay studio rarely produces more than 5 min. of music or dramatic continuity in a working day. Animated movie cartoons are, likewise, too high priced for production exclusively for television. The average cartoon film costs about $2,500 per minute of projection time.

These basic costs place before present television broadcasters a tremendous obstacle, and at present no satisfactory arrangement has been worked out whereby films produced for cinema houses may also be broadcast to homes. Nor can it be expected that producers will grant a national system of television priority rights for exhibiting feature films by television. Such a practice would dull the edge of public curiosity and so reduce box-office receipts. There may be a potential interest on the part of televiewers, however, in film that has had a national run in theaters.

The initial attempts to secure films have indicated that productions of commercial sponsors and those of the older independent film companies and foreign title films may be secured at reasonable rental figures. The cost of broadcasting rights to films other than those mentioned, however, exceeds the expense of producing satisfactory television programs of artistic merit in live-talent studios. Nevertheless, the film industry or the broadcasters may develop a workable plan for providing television material as a by-product of the main production, such output to be made available at a cost that compares favorably with other methods of television programing.

There are several other ways in which the movie industry could produce material for television. For instance, in connection with the production of almost every film, considerable surplus, or "overtake," negative is removed from the dramatic continuity in the film-cutting room. Ordinarily, this overtake is waste. In some cases, it might be possible to combine the finished film with the overtake and thus expand it into serial program material that could be televised at, say, one reel per day. The serialization would, of course, take place after the films had been exhibited in theaters. The possibilities for a dual use of semihistorical films like "Mutiny on the Bounty," "A Tale of Two Cities," "Emile Zola," and "Marie Antoinette" are attractive. Additional methods of utilizing film from the cutting-room floor will no doubt suggest themselves on further exploration of the subject.

It is essential, then, to weigh the techniques and economics made possible for television by movie film. Present trends indicate that research in celluloid entertainment will become closely identified with practical research in the fields of sight and sound broadcasting.

Film especially taken for television can undoubtedly be produced by a technique quite different from that used in normal motion-picture production. Certain tolerances and latitudes will be permitted, and, as discussed elsewhere, the tempo will be speeded up. There will be more numerous close-ups due to the resolution of the television system. For instance, in a film being taken of a baseball game, the head and shoulders of a player might fill the screen for a few seconds, followed by a quick switch to his stance at the bat. Then a longer shot would show him running to first base. In this position, the image of the player would be quite small, but the recollection of the face and the figure would be mentally carried to the running figure. As the ball was being caught by the center fielder, the process might be repeated, so when the final picture of the whole field came on the screen with the figures (perhaps not more than ½ in. high), they would be recognizable from their actions of running and throwing the ball, and the mind would carry over the details.

For syndication, reruns, or purposes of the record, standard motion-picture film may be taken in the television studio immediately before or after the broadcast. The scenery is in place; ample lights are available; the actors are in costume and know

their parts. Several difficulties arise in this aside from the expense, for it is not easy to simulate with film cameras the switches between the several television cameras. A far simpler process would be to take a motion picture directly from a picture-tube screen of a receiver designed for the purpose.

It appears highly desirable to devise a standard method for recording television programs in central studios, both sound and sight, thus making possible the economical transportation of such recordings to other cities for rebroadcast. Preliminary experiments indicate that suitable apparatus for such recordings can be built. But any plan for recording programs with standard movie-studio techniques and equipment appears doomed to failure, since the figures indicate that the hope of bringing costs within practical limits is rather remote. If, by new methods, costs could be cut to even one-tenth their present amount, they still would be excessive for television purposes until a very large audience had been built up. It seems unlikely that television can reduce costs unless it succeeds in developing an entirely new technique.

Standard movie procedures have been developed on the basis of the financial returns from motion-picture exhibition, which are much higher than can be hoped for from broadcasting a single film drama. The movie industry achieves excellent results from these methods because they are commensurate with the financial structure of the motion picture.

Inquiry into the practices and problems of films shows, therefore, that the methods in television production must depart from those in the movie industry because the respective requirements are fundamentally different.

Although film for television cannot be produced on the lavish scale customary in Hollywood, there is little doubt that television-program departments will make extensive use of film for their own purposes, for syndicating programs and as an adjunct to live-talent programs. The television industry, thus far, has made no move to standardize the film that it produces for its own use. At present, the wide availability of 35-mm. equipment in professional film-producing studios and the fact that equipment for transmitting 35-mm., 24-frame film is available have given the advantage to the type of film standardized by the movie industry, despite the fact that such film is not ideally

suited to television purposes. The discrepancy between the 24-frame rate of standard movie film and the 30-frame rate of the television system has already been mentioned. Film produced especially for television might be produced at 30 frames per second, thus overcoming the difficulty at its source. However, the advantage of employing 30-frame film for television purposes is slight, so long as professional movie film (24-frame) must be used at all. Once projection equipment for 24-frame film has been installed, it would seem wise to produce all further film at the standard 24-frame rate.

The case for the professional movie standard is not so clear when the size of the film is considered. Since cost is such a controlling item, it is worth while to consider the comparative costs of 35- and 16-mm. film. The detail-transmission capabilities of the television system at present lie somewhere between the degrees of detail present in the 35- and 16-mm. film. Consequently, when 16-mm. film is shown, the detail in the reproduced image is not much poorer than when 35-mm. film is used. The cost of negative stock, developing, printing, and positive stock is very much less for the 16-mm. film, however. The 16-mm. film requires less storage space, is not subject to fire hazard, and operates in less expensive and more portable camera and projecting equipment. Failing some new standard for film produced exclusively for television, it appears that both 35- and 16-mm. film will continue to be used and that projectors suitable for these two forms must be available.

A source of film supply that has been considered, but for which no definite plans have been formulated, is the thousands of feet of 16-mm. film made by amateurs. Throughout the country are many active clubs that produce creditable film, and many travelers from abroad bring back pictures of high quality and interest. Already the travelogue film has proved highly enjoyable television fare.

The whole problem of film on television involves the balancing of negative and positive factors. On the positive side, there are the following:

1. Unlimited flexibility of material.
2. Control of material.
3. Perfection in production.
4. Ease of scoring of musical and sound effects.

5. Feasibility of gathering and presenting news from many places.
6. A minimum human element involved in the transmission of the program.

The elements that work against the use of film on television are:

1. The high cost of production and distribution.
2. The lack of immediacy and spontaneity.
3. The difficulty of recording sound as well as it can be picked up in a television studio directly.

Demonstrations of projection tubes in receiving sets capable of throwing pictures 10 or 12 ft. across have been produced, showing the clarity and brilliance necessary for limited theater use. They are too large and expensive to employ in the home, but are intended as auxiliaries in theaters. For special events of high importance such as a championship prize fight that may be definitely scheduled in advance between films, projection television may have a definite use. On a monitor in his office, the theater manager could see what was coming over the regular system; and if an unexpected event of sufficient importance flashed on the screen, he might cut the regular show to present the television flash to his audience, just as sound-broadcast programs are occasionally cut for flash news of high importance. Television programs could be supplied to theaters by special cable from a central point; they could be picked up from the air from the regular broadcast transmission; or it is even possible that a special transmitter with a special frequency assigned for theater use only could be utilized. Considerable development will have to be done in projection-tube receivers before it will be possible to present at a theater a regular feature picture that gives the audience what it has learned to expect from present-day film projecting equipment.

But, with all of this, it must be remembered that television supplies a different human need from that supplied by motion pictures. Television is essentially home entertainment and will present items totally different from the normal fare of the motion-picture theater.

"Going out" is an event, a welcome relief to the housewife who has been home all day. The moving-picture theater not only offers the opportunity of escape but satisfies the gregarious instinct of enjoying something with others.

CHAPTER VII

OUTDOOR PICKUP BROADCASTS

Of all the possible types of television programs, those which show events as they happen create the greatest interest. For here is the closest approach to complete realism—an event happening before the viewer's very eyes. He realizes that he is

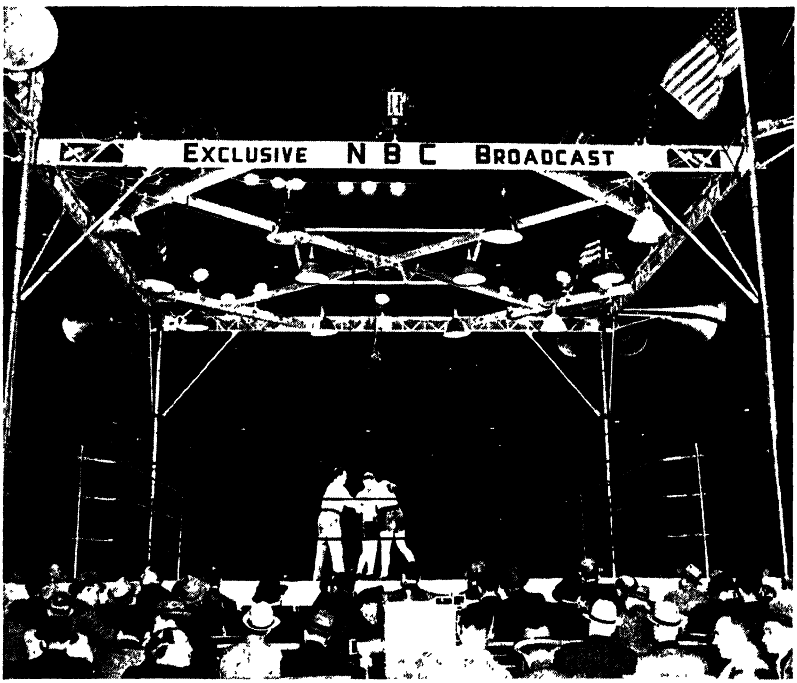


FIG. 37.—Television camera (foreground center) picking up the Baer-Nova fight at Yankee Stadium, June 1, 1939.

seeing the scene firsthand, without the intervention of a third person to interpret the event. Also, an atmosphere of suspense is offered. If the unexpected happens, each member of the audience will have a ringside seat while it occurs. The impor-

tance of suspense is well illustrated by sports. After all, most football games are alike. In each of them the ball is kicked, the player runs, tackles are made, the crowd cheers—by and large, they are as alike as two peas in a pod. But—because of the continual element of suspense—seeing one football game is no discouragement to seeing another. Will the runner get away? Will he run for 10 yd. or 20? Will it be a touchdown? Television offers this moment-to-moment expectancy of the unknown

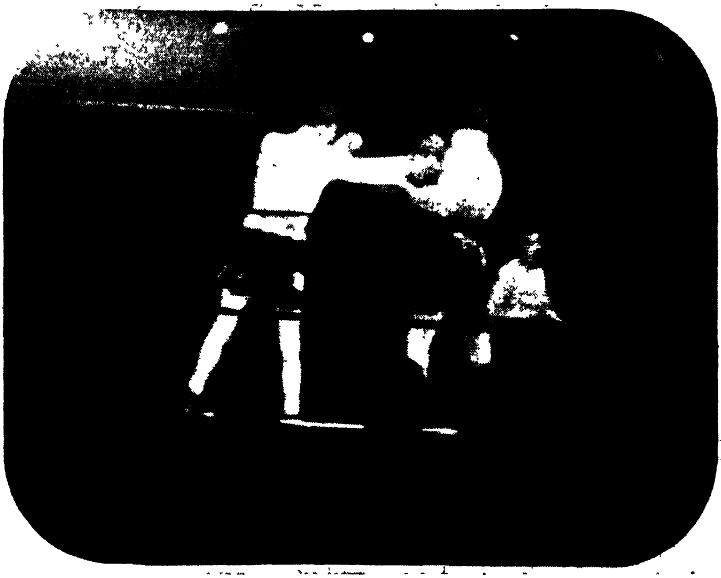


FIG. 38.—The Baer-Nova fight as seen via television.

or the unusual happening. Seen in a newsreel, even on the night of the game, that suspense is lessened. Answers are known —the newspaper or the radio has told the score and who made the outstanding plays. The film version is interesting to see, of course, but the element of suspense is weakened. So it is with any event—a fire, a riot, or merely the crowds on Broadway. If something spectacular or unforeseen does happen, the viewer will be there to see it.

Obviously, then, a function of paramount importance in television is the projection into the home, by means of sight and sound, of news and other events as they are taking place. To

see things while they are happening intrigues the imagination strongly. In fact, the average person's conception of what television means to him is that of a sound newsreel operating directly from the spot where something is going on. He expects, for instance, to *see* a football game instead of simply hearing a description of it.

The outside pickup may be made in a variety of ways, and the signal may be transmitted back to the main sending station in

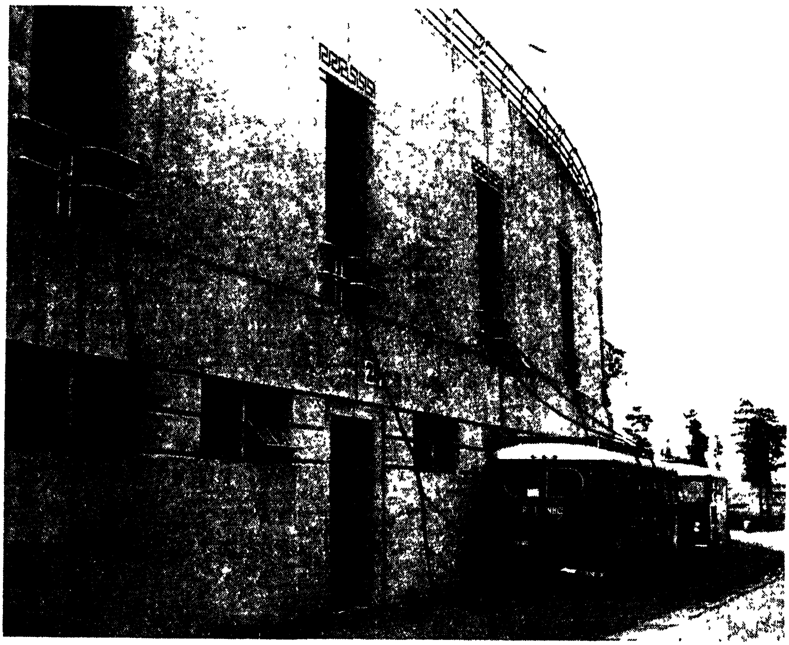


FIG. 39.—The trucks parked outside the Randall's Island Stadium during the ICAAAA Track Meet in the summer of 1939.

one or more of three ways. For comparatively isolated locales, a completely mobile unit mounted in a truck, including cameras, relay transmitter, antenna, and power supply, is needed. If power from the local utility company is available, the mobile power facilities may be dispensed with. If the pickup is not too far from the transmitter and specially adapted telephone lines are available, the program may be sent over these wires. Or, in certain locations such as Madison Square Garden, from which broadcasts are frequently picked up, semipermanent

equipment and coaxial cable may be installed. Moreover, the outside pickup may be made with equipment not directly associated with the mobile equipment mounted in trucks. Portable equipment may be taken and set up for relatively short periods at any point of program supply. Whether the program is picked up by mobile units or by portable equipment, program material originating away from the studio is considered an "outside pickup."

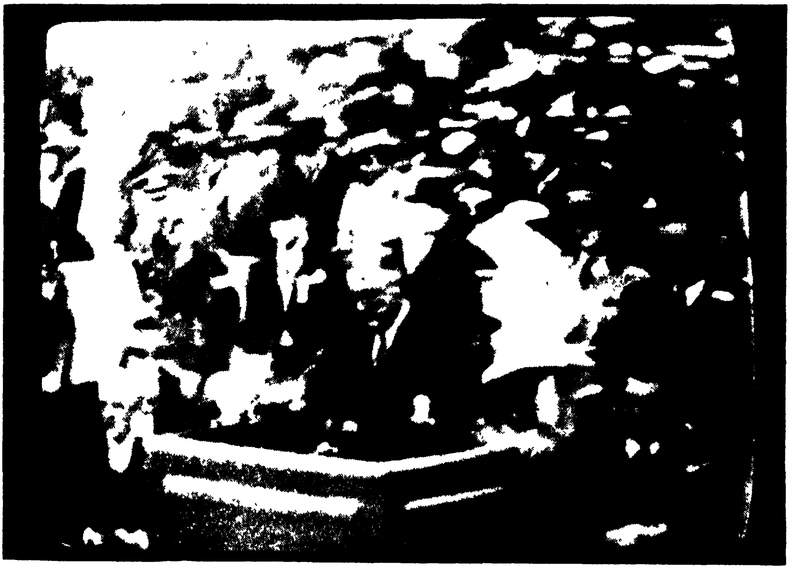


FIG. 40.—President Roosevelt, speaking during opening of the New York World's Fair, Apr. 30, 1939, as seen by television.

Until recently, it has been assumed that telephone wires would not be available for the transmission of television programs, since 10,000 cycles per second is the highest frequency that can normally be transmitted over ordinary telephone wires, whereas television requires a minimum of 3,000,000 cycles per second. However, recent experiments have demonstrated that, by arranging special terminal equipment and equalizers, television signals may be transmitted over conventional telephone circuits for a number of miles. In spite of the importance of this development, it still does not seem practical to use telephone wires for connecting television stations in different cities, although they

may have an extremely important part in local programing. In a metropolitan center, a network of such wires will greatly simplify the outside pickup problem. An event may occur at any one of a thousand points. To rush simple portable equipment to the spot and transmit the program to the studio—without the need of a large power supply—would not only simplify but greatly speed up the transmitting of events. It

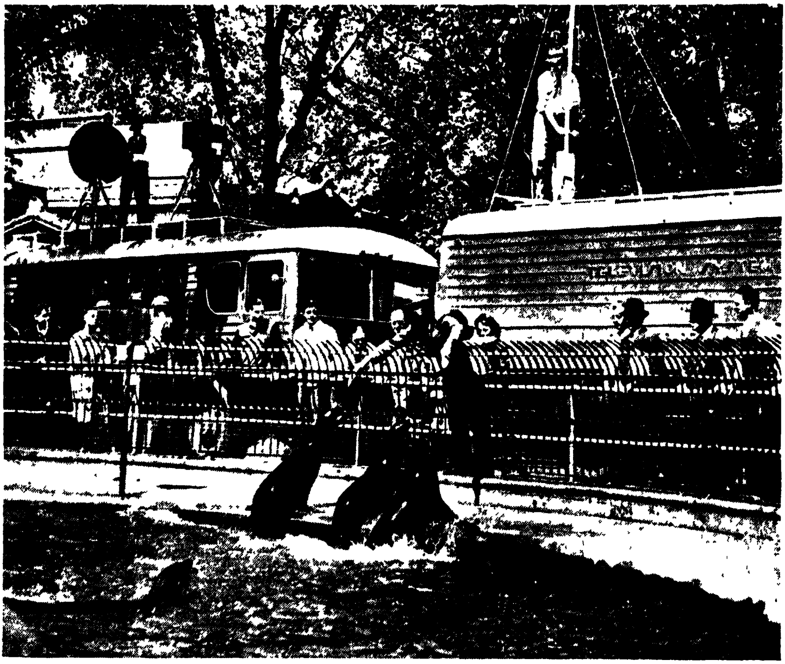


FIG. 41.—Television took its audience to the Bronx Park Zoo during one of the earlier broadcasts.

now seems that the limiting distance for this type of service will not exceed 10 miles, which permits picking up a majority of the events happening within most cities.

Sporting events, parades, and other items of news interest that are scheduled well in advance do not present the difficulties of the unusual or spontaneous event. Although spontaneous programs certainly have high interest, they present proportionate difficulties. For instance, a fire might well be under control before the television apparatus could arrive at the scene and

get the image on the air. Also, at times of day during which there is limited program service, an event may happen when the transmitter is not scheduled to be in operation. And, though it would be quite possible to put the transmitter on the air before the mobile crew arrived on the grounds, if this occurred outside the scheduled broadcasting period, there might be no viewing audience. It is possible also that a warning device could be

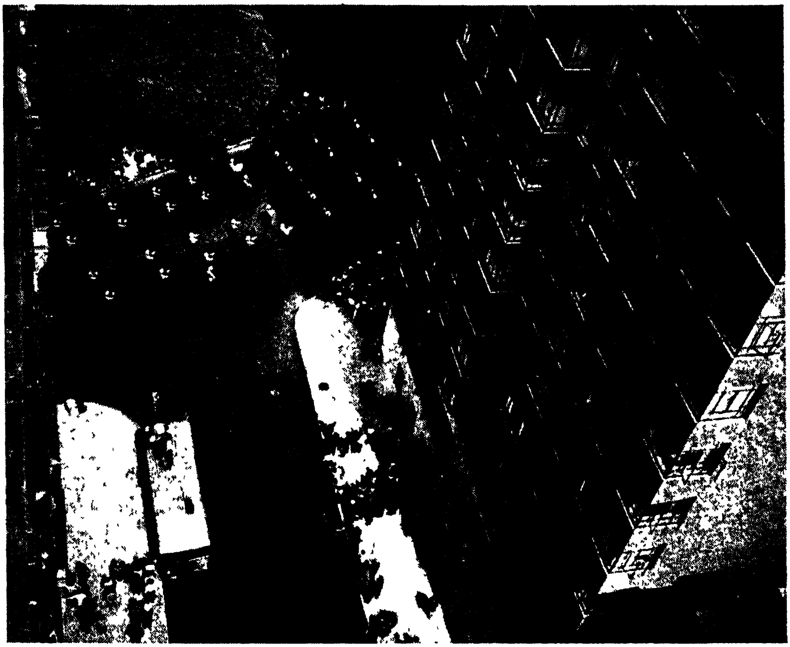


Fig. 42.—Housetop view of the mobile unit, televising the Memorial Day Parade of 1939.

placed on the home receiver so that the owner could be made aware of a broadcast coming at a time outside the regularly scheduled presentations.

The mobile units of the National Broadcasting Company were used to relay all the outside broadcasts during 1939.

These pickups included such events as the opening of the New York World's Fair, the Memorial Day parade, a collegiate baseball game, a 6-day bicycle race, a swimming meet, a track meet, several pickups from the grounds of the World's Fair, and the complete running of the Eastern Grass Court Tennis Champion-

ship Matches at Rye, N. Y. The last was the most ambitious sporting event pickup to date. It included three afternoon broadcasts, some 6 hr. in all, and included the full course of the semifinal and final matches. These events were all of the "scheduled" variety. One "unscheduled" broadcast occurred prior to the opening of public service. The trucks were making a test near Ward's Island when a fire broke out on the island, separated from them by the river. The trucks immediately

FIG. 43.—Another view of the mobile unit covering the Memorial Day Parade.

relayed the fire to the Empire State transmitter where it was put on the air for the benefit of a small audience composed of RCA and NBC personnel and a few amateurs. On another occasion during a similar test in Rockefeller Plaza, the television cameras happened to televise a woman's suicide leap from a window in a near-by building. None of this type of program has appeared since the inauguration of public programs, largely because of the great number of scheduled events which preclude holding the trucks available for spot-news eventualities. The program department is keenly aware of the virtue of using the

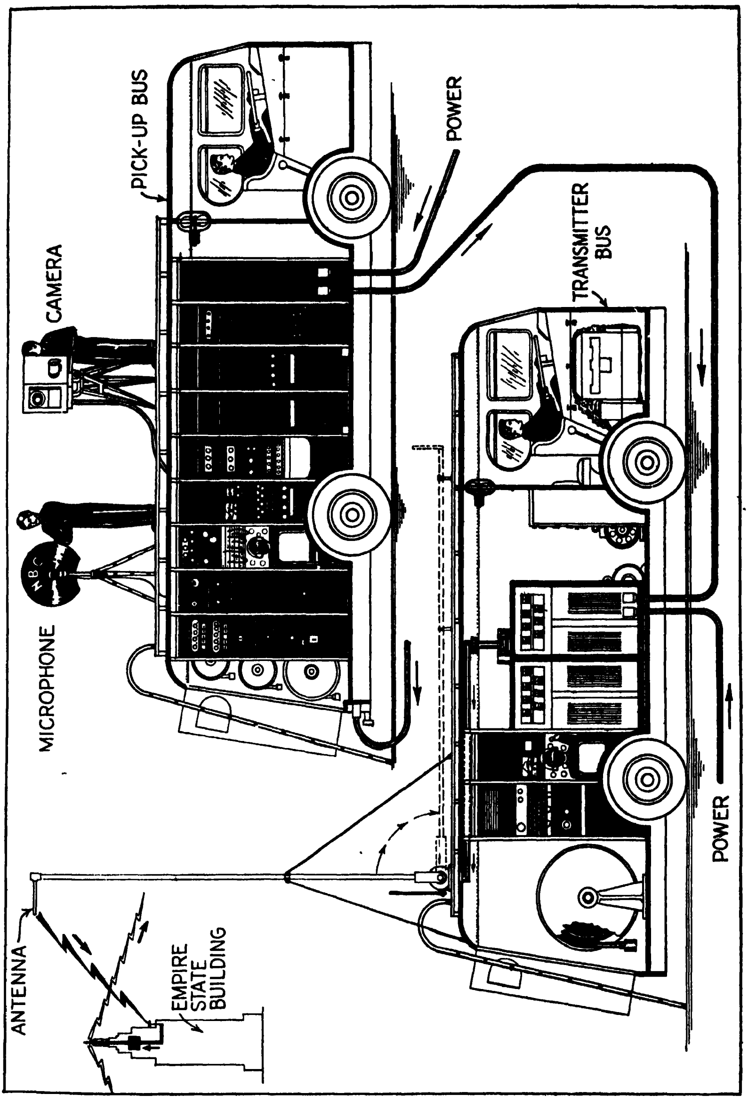


FIG. 44.—The television mobile unit. The upper unit is equivalent to a studio control room; the lower unit contains the radio transmitter used to relay the television signal to the Empire State Building for rebroadcast on the main transmitter.

trucks for unscheduled events during scheduled program hours wherever possible.

America's first television station on wheels made its debut in the spring of 1938, when NBC began experimental field oper-

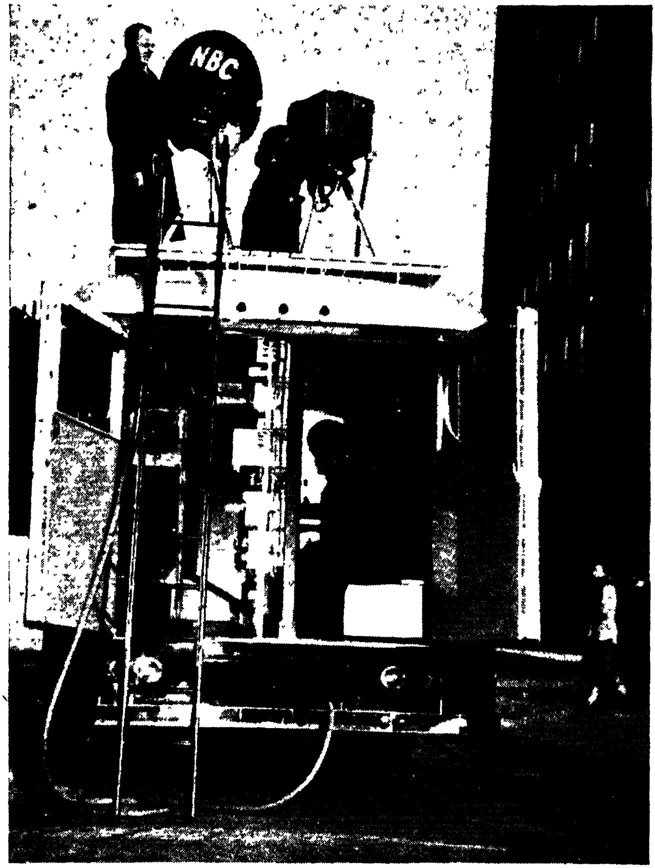


FIG. 45.—The rear of the monitoring truck, showing engineer at controls in the truck, camera mounted on top, and engineer operating a parabolic microphone for sound pickup.

ations in the development of television out of doors. The general aim of these preliminary experiments is to learn how well telemobile equipment (television equipment mounted in trucks) functions under field conditions; to disclose weaknesses; and principally to test the ability of the system to cope with weather

conditions, topographical difficulties, natural and artificial lighting problems, and man-made electrical interferences.

The mobile unit was designed and constructed by the RCA Manufacturing Company. It was originally equipped with one

FIG. 46.—The control position in the radio transmitter truck.

television camera, which limited somewhat the type of pickups that would be made. In August, 1939, it was equipped with a second camera chain, making it possible to cover outdoor events more completely. One camera with a wide-angle lens and the other with a close-up lens make it possible to switch from one

scene to another, thus presenting a more complete coverage of the event.

The telemobile unit consists of two buses that have specific functions. The picture bus contains equipment for televising an outdoor scene; the transmitter bus includes the transmitter and a collapsible antenna which radiates a signal that can be intercepted at a distance, then amplified and rebroadcast.

In operation, the buses are connected by cables unreeled from large spools. The two cameras are connected to the picture bus

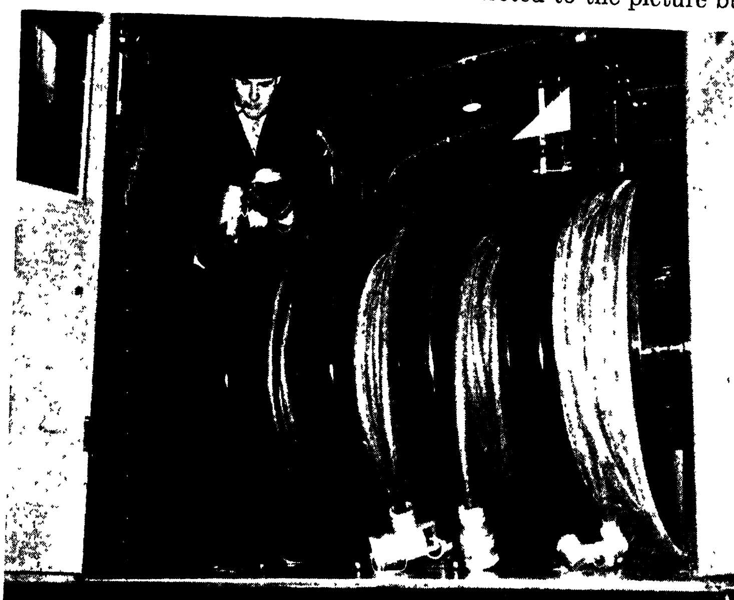


FIG. 47.—Reels of cable in the rear of the transmitting truck.

by cables composed of 32 separate conductors. The camera can be set up on its tripod anywhere within a radius of 250 ft. from the bus and can televise a scene as large as the Yale Bowl or as small as the palm of one's hand.

Preliminary field work was concerned with the camera's limitation in respect to sudden light changes, as, for instance, when a cloud obscures the sun; also with definition, depth of focus, dependable range of transmission, weather conditions affecting signal strength, and the Iconoscope's reaction to shades and colors as seen by outdoor light. Also, it was necessary to

determine exactly how long it takes to set up and pack equipment under varying conditions.

It takes many kilowatts of electrical power to operate the mobile units, including the power for the relay transmitter. Since it is necessary to plug into a source of power supply, mobility is limited by the general lack of suitable outlets for such a large

FIG. 48.—An outdoor-type television camera mounted on a motion-picture-type tripod. The funnel-shaped hood on the front is to shield the lens from stray light.

amount of power in the field. The obvious solution is to provide a portable source of power. Although such a power truck is not a part of the mobile equipment at present, it is under consideration for the future.

When televising an outdoor scene, the camera operator finds an appropriate position, while a sound engineer, in charge of a portable hand microphone or a large reflector microphone, handles the sound side of the broadcast. In the darkness of the

picture bus, a sight engineer monitors the image on a Kinescope screen; beside him sits an engineer who monitors the sound pickup, and simultaneously two other engineers attend to the operation of the transmitter which sends the signals to the dis-

FIG. 49.—A monitoring position in the picture-bus truck. This is a piece of equipment similar to that described previously in connection with the live-talent studio equipment.

tant transmitter. A telephone installation enables the personnel outside and inside the units to carry on conversations. Talking back and forth plays a large part in outdoor television.

Tests indicate that upon arriving at a location, the unit can go into action within 25 to 75 min. if a power outlet or a power-supply truck is available. Before traveling to another location,

equipment must be reloaded, and this requires 20 to 60 min. Under present program schedules, it will be difficult for the telemobile unit to broadcast from more than one location per day. Here, the radio relay has an advantage in that it permits

FIG. 50.—Another view of the control position, showing the audio and video engineers at work. In the rear, an engineer is monitoring the picture on a home-type receiver.

the telemobile unit to travel to any locality within range of its relay transmitter and begin broadcasting within an hour. No such flexibility of operation is possible with coaxial cable, which requires months to install and, when ordered to any particular location, may have little use after a single broadcast.

One handicap to relaying by radio from the telemobile units is the problem of obtaining sufficient height for the antenna to offset the limited range of ultrashort waves. The range of a transmitter is in direct proportion to its altitude, and of course an antenna mounted on a truck is not very high. This has, on occasion, proved a drawback to field operations from certain locations, especially when there are obstacles in the way. However, special antennas have been developed for field use which direct the signal toward the central transmitter, and this device is proving helpful to a considerable extent. There will be extensive developments in the telemobile transmitter field. The use of shorter wave lengths, specialized directive antennas, and the use of several receiving locations may prove beneficial.

In the latter part of 1939, the mobile unit was equipped with a new refinement in television cameras. The new camera contains an Orthicon tube in place of an Iconoscope (both of these tubes perform the task of converting the light images into electrical equivalents). The more sensitive Orthicon camera has made it possible to pick up outdoor events under conditions of low light which would be insufficient for satisfactory pictures using the Iconoscope. Also some advance design ideas in the new field camera have made it possible to follow action more closely and interestingly for the audience.

In the process of trying out many ideas in the mobile unit, a remote focusing arrangement for the camera was installed for tests. With this arrangement, the television camera could be focused by means of motors, built into the lens housing of the camera, all controlled from within one of the mobile trucks at the monitoring position. In other words, the engineer, who is responsible for the technical quality of the image as viewed on the monitor screen, was able to get the sharpest possible focus. However, this idea may be discontinued, or used interchangeably, with the more convenient method of focusing, by the camera operator.

A partial list of problems that now affect outdoor television follows:

It is difficult to meet nonscheduled spot-news events. Even if news happenings are relayed with all possible speed, it takes considerable time for the mobile unit to reach a scene and set up the equipment for action.

Since speed of operation is essential to outdoor television, it is conceivable that the cameras will not always televise scenes from proper locations, and televiewers may be disappointed.

In many outdoor-news events, such as the docking of a ship or a parade, there are intervals when action stops for an extended period, and the program may become monotonous and lose its significance. Techniques must be developed to counteract this factor. The use of several cameras a considerable distance apart and a switch to the main studio are possible solutions.

If an outdoor program service is to approach the standard of dependability set by sound radio, it is necessary to assure the transmission of programs regardless of mechanical or other unforeseen difficulties. When outdoor pickups are scheduled as part of a daily program, a studio stand-by program (usually a film) is held ready for broadcasting at a moment's notice in case the outdoor pickup does not materialize. Similar difficulties in sound-radio broadcasting are overcome by employing a stand-by pianist, organist, or orchestra to fill a possible break. Although an elaborate television show might be kept ready in the studio, gaps in remote broadcasting are more likely to be covered by the use of film, easily available at short notice.

In December, 1939, NBC acquired new portable television equipment which can be transported in a light delivery truck. At this writing, one notable demonstration had taken place with it. Loaded into a United Airlines plane, it recorded a sight-seeing flight over Manhattan. The images were clearly received at Schenectady and the experiment indicated that the flexibility of the new equipment, as well as its light weight, opens up many heretofore impossible pickup points.

Certain popular forms of broadcasting take on an added interest when shown on television. The Vox Pop type of street interview has always been popular, but new elements of interest appeared at a recent experiment with this type of program, when the mobile units were employed to televise sidewalk interviews. Although no humor was intended either by the master of ceremonies or by the actors, the actual broadcast was uproariously funny, this fact remaining unknown to the participants. The master of ceremonies introduced a gentleman from the crowd and asked him some of the standard questions about his home town and why he was visiting New York. His embarrassment

and fright from his experience, which would have been completely missed over sound broadcasting, was clearly shown to the television audience—particularly when he knocked over the microphone stand in his frantic effort to get away. Another gentleman on this same broadcast, who happened to be a dis-

FIG. 51.—Count Jerzey Potocki, Polish Ambassador to the United States. Above, as he appeared before the television camera, and below as he appeared on a television screen. These pictures were taken during a television demonstration held in Washington, D.C. in February, 1939.

tinguished visitor from abroad, was not so affected. With both hands clinging to the microphone, he delivered an oration and completely baffled the polite and adroit efforts of the master of ceremonies to terminate the interview. The latter's distress at his repeated failures were quite evident and highly amusing.

The importance of the outside broadcast as an element in a well-balanced television program service can hardly be overestimated. Experience with the NBC audience thus far has shown definitely that television's unique ability—that of bringing events as they happen into the home—is also its most appreciated feature. Whereas a television station may build and maintain an audience without a mobile unit for outside broadcasts, it

FIG. 52.—Vox Pop televising in the rain. Here the camera and the microphone have raincoats for protection. The occasion was an interview during the Washington D.C. demonstration in February, 1939.

is certain that simple portable equipment for remote pickups will become an increasingly important part of every television-station plant. The elaborate (and correspondingly expensive) truck installations may not be justified for stations in the smaller cities, but simpler equipment is already available at a price well within the means of the small television station, and it can readily be adapted to use in the field. One such simple portable unit has already been used by NBC on scheduled programs within the studio, and its adaptation for outside broadcasts is now in progress.

CHAPTER VIII

THE PROBLEM OF NETWORK TELEVISION BROADCASTING

A partial answer to high cost in the production of high-quality entertainment, be it for television, sound broadcasting, or the movies, is found in syndication to the largest possible audience. In motion pictures, the huge costs of production are met by exhibiting the picture in several thousand theaters. In sound broadcasting, the corresponding system is the network of radio stations, a comparatively new syndication device but one that has had outstanding success. The analogous possibility of syndicating television broadcasts over a national network is immediately suggested. If a single television program can be radiated simultaneously to many thousands, even millions, of televiewers in widely scattered cities, the program has its maximum circulation, and the cost is spread over a number of economic units.

If network broadcasting for television were as feasible technically as it is for sound broadcasting, the economic problems would be relatively simple. Network connections between television stations are technically possible, but necessary facilities are not yet in existence, and their construction cost will be an important factor. When service was first introduced to the public, there were no fully developed means of broadcasting the same program simultaneously from more than one station, unless recorded on film and sent to the stations, as transcriptions are now used. However, just as the present universality of sound broadcasting rests squarely on network operations, television, where immediacy is of greater significance, because equivalent to seeing as well as hearing over great distances, will rely to even greater extent upon networks for simultaneous broadcasting of programs.

Since the network problem is such an important one in television, it is necessary to discuss its phases, both actual and potential. First, we shall review the technical problem that makes the connection of stations so difficult. Secondly, we shall trace

briefly the growth of the network in sound broadcasting in view of its possible bearing on the development of the television network. Finally, we shall describe some of the means of television-program syndication that are at the command of the broadcasters, including the coaxial cable, the radio relay, the photographically recorded program, and the traveling troupe of performers—each of which may find a place in television.

To interconnect a number of television broadcasting stations requires a communication system (either wire or radio) which is capable of transmitting the picture over distances of several hundred miles with satisfactory fidelity.

In present-day sound broadcasting, conventional telephone-wire circuits can be converted for program service with minor modifications. Hence we find that the sound network is, in reality, a network of telephone circuits. The ordinary telephone circuit, even with special equalizing equipment, cannot transmit a television-picture signal more than a few miles without so distorting it that it loses its entertainment value or becomes altogether unrecognizable. This sharp contrast in the ability of a telephone line to transmit audible, as against visual, information results directly from the fact that the sight system must transmit vastly more information in a given time than the sound system transmits.

This fundamental difference may be examined very simply. The sound signal is an electrical counterpart of the sound waves that impinge upon the microphone. These waves vibrate at various rates, depending on the pitch of the sound. Thus, the bass notes consist of vibrations of 50 to 150 per second, whereas the highest pitches vibrate from 3,000 to 6,000 cycles per second. The harmonics or "upper partials" of the highest pitched notes that give sound its timbre, or quality, contain vibrations of still higher frequencies, up to 20,000 per second. Vibrations occurring at a more rapid rate than this may exist in the physical sound waves, but they are of no importance, because the normal human ear does not respond to sound waves having frequencies higher than 15,000 per second (20,000 per second for a highly acute ear). The electrical problem is correspondingly simple. It is necessary to devise a suitable system of circuits that will transmit electrical vibrations in the range from 50 to 15,000 cycles per second. The reproduced speech or music in such a system will

have an effect of realism which, in some cases, would make it difficult to distinguish the reproduction from the original. Telephone lines may be designed to pass this type of electrical signal.

But when the television signal is considered, we note that the picture impulses are generated at a rate of roughly 6,000,000 per second in order to reproduce 30 complete pictures per second, each picture containing 200,000 elements. When the 6,000,000 picture impulses are converted into their electrical counterparts, they involve 3,000,000 complete cycles per second. The occurrence of these waves is roughly two hundred times as rapid as the upper limit of the sound system just considered. The two hundredfold increase in the rate of transmitting information is far more than a conventional telephone system can handle. If such a picture signal is impressed on a telephone line, the fine detail corresponding to the 6,000,000 picture elements per second is lost, and only the very coarse features of the image (which are reproduced at a slower rate) are transmitted. This limitation applies particularly to the wires themselves and partially to the repeating amplifiers, which are located at intervals along the line and to the terminal equipment in the exchanges.

To devise a telephone circuit capable of transmitting a detailed picture signal is not impossible, if the distance is not too great. Telephone wires have been used, for example, over distances of several miles, by the use of special amplifiers and equalizers which offset the shortcomings of the wire circuit itself. The initial use of such a circuit in a public broadcast, as described elsewhere, was in conjunction with the 6-day bicycle races from Madison Square Garden, for which a telephone circuit was equalized to carry a maximum video signal frequency of 3,000,000 cycles per second. But to do so, amplifiers were required to boost the response of the circuit over a million times, in just one mile of wire. Furthermore the circuit employed had to be free of connections with other telephone equipment, and careful measurements on its characteristics had to precede its use for television work. The experiment showed that short lengths of telephone wire (a few miles) may be used for program relaying purposes. This is indeed a useful system, since it permits picking up outside broadcasts that occur close to the transmitter but that are not convenient to a coaxial cable installation.

For carrying picture signals over greater distances, an entirely new kind of system is needed, which uses coaxial cable and repeater amplifiers capable of carrying the wider range of components in the picture signal. The beginnings of such a system have already been laid down by The American Telephone & Telegraph Company. There is only one coaxial cable link between New York and Philadelphia capable of handling a television image—and even this cable cannot handle the full detail of a 441-line image at present. The system is expensive, not only because of its first cost and maintenance but also because it has many other uses with which television must compete. The Philadelphia-New York coaxial cable has the ability to handle about 800 long-distance telephone conversations at once, which makes its utility as telephone equipment great. Its cost to television broadcasters has not yet been determined, and the economics of its use must await further developments. For interstudio and master control-room connections, coaxial cable is well-nigh indispensable, but high initial construction cost militates against its extensive use in network operations except under highly favorable circumstances.

The modern coaxial cable consists of a metallic conductor held in the center of a cylindrical metallic sheath by insulators or an insulating medium. The atmosphere surrounding the center conductor can be of normal pressure, a partial vacuum under pressure, or wholly or partially gaseous, depending upon its function. In the case of flexible coaxial cable, this space is sometimes filled with insulating beads or fabric.

Present indications are that a coaxial-cable line designed for television will require repeater amplifiers at 5- or 6-mile intervals. Experiments show that these amplifier units can be controlled from central points and that regular service can be maintained with occasional inspection.

The possibility remains of employing radio as the connecting link between television broadcasting stations. When radio is utilized for this purpose, the communication system for connecting the television broadcasting stations into networks would consist of a series of the radio relay stations, each of which in turn would pick up the picture signal from the relay preceding it and "repeat" or pass it along to the next relay. By this process of repeating from one relay to the next, the picture signal

could be transmitted over distances equaling hundreds of miles and could be delivered to any number of television broadcasting stations along the route. As this book goes to press, the Radio Corporation of America has just demonstrated the successful operation of such a radio relay system for network connection and has announced that it is feasible to interconnect several cities; for example, New York, Washington, D.C., Boston, and their intermediate cities.

In such a system, low-power "automatic" or unattended relay systems would be located at intervals of approximately 20 to 30 miles along the route of the circuit. These stations would use

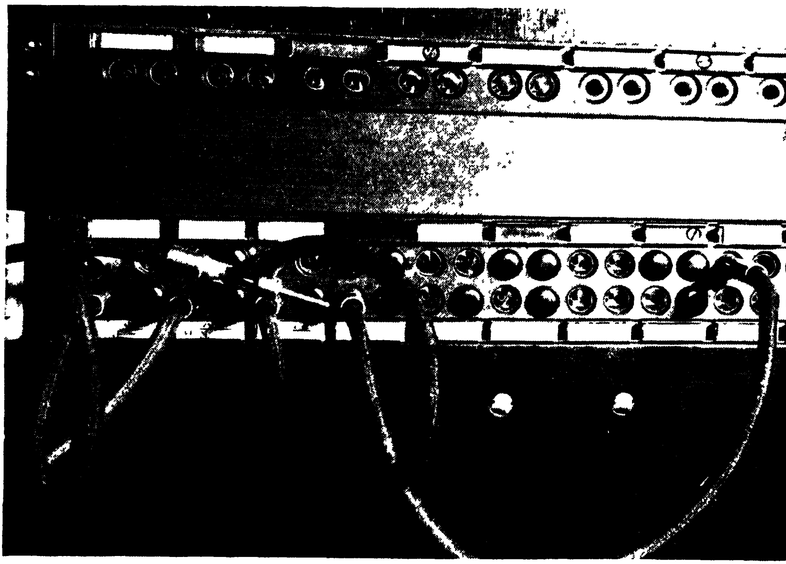


FIG. 53.—A coaxial-cable jackboard connecting studio and apparatus.

much higher frequencies than those used by the various television broadcasting stations; for example, frequencies of about 500,000 kc., or wave lengths of about 60 cm. (0.6 meter).

This circuit would take the picture signals directly from the studio at the point of origin of the program and pass them along from one relay to the next until the full distance was reached over which the program was to be distributed. The signals carried by the system would be delivered to television broad-

casting stations at intermediate points, and the relay chain or any portion of it would be capable of being reversed to permit transmission of programs in either direction.

The use by the broadcaster of very short waves in radio relay systems offers a number of advantages. One of these is the opportunity offered to construct highly directive transmitting and receiving antennas. The purpose of such antennas is to take the radiated waves away from those areas in which they are not needed and concentrate them in the desired direction, so that a much greater proportion of the total energy radiated by the transmitting station may be intercepted by the receiving station.

Since these "rifle" antennas would transmit so much of the original power in the desired direction, the amount of energy from the initiating source can be relatively small, thus permitting utilization of low-wattage relay transmitters of perhaps 20 watts or even less. This, of course, would be an important contribution to the economic problem of inexpensive operation and also it would make feasible the use of "automatic" or unattended stations further to lessen operating costs to the broadcaster.

The engineering of such a television relay system involves many problems in addition to the obvious fundamental technical problem of transmission and reception. Interdependent variable factors include height of antennas at each relay station, considered together with the terrain between stations, distance between stations, power of transmitters, and the degree of directivity of antennas. Total cost must be minimized by obtaining the optimum balance between all these factors.

The development of this radio relay system for connecting television broadcasting into networks has been made by the research staff of the RCA Communications, Inc., and it utilizes the results of extensive original research conducted by RCA Laboratories.

We may visualize a chain of these relays covering the 1,000 miles from New York to Chicago, separated, say, by 25 miles and numbering about 40. They would be automatic in operation, unattended except for maintenance and emergencies, capable of handling two or more television channels with "cue circuits" or intercommunicating telephone channels, reversible for programs going in either direction, and supplied with duplicate

equipment placed in operation by remote control in the event of any failure. It should be said that, up to this time, serious consideration of such a comprehensive network is not being given.

So the establishment of a radio relay system must either await the development of an audience large enough to support at least part of the initial construction and development expense or the broadcaster must go on the principle of dividing program costs over a number of stations. In the one case, the whole question of network development will be predicated on the demand of the audience for programs that cannot be syndicated in any other way. On the other hand, division of financial burden among stations would more quickly build up the audience in the localities served. This could be accomplished by circuits to interconnect television broadcasting stations. In this fast-moving field, it is useless to predict six months in advance what will happen.

In view of the many intermediate problems that the future of television-network broadcasting now faces, it is worth while to turn back the pages of recent history and inquire into the problems that faced the sound-broadcasting industry when it began nearly 20 years ago, in their relation to the analogous situation in television.

The Radio Corporation of America was organized in the fall of 1919. Among the many inventions useful in the radio art then owned by the General Electric Company, was the Alexanderson alternator for generating high-frequency currents especially useful in long-distance radio communication. Officials of the Navy Department of the Government desired to prevent these valuable inventions from falling under the control of foreign interests. Accordingly, they were active in urging creation of a radio company, to be owned at least 80 per cent by citizens of the United States, which would acquire control of the patents on the Alexanderson alternator, would establish and operate an international radio communication system capable of competing successfully with foreign-owned radio and cable communication companies, and would also generally develop and advance the radio art. On Nov. 20, 1919, the newly organized Radio Corporation of America, having acquired radio licenses and rights under the patents of General Electric, entered into an agreement with the Marconi Wireless Telegraph Company of

America whereby RCA, in exchange for shares of its own stock, acquired the physical properties, patents, licenses, and good will of the Marconi Company.

Westinghouse proceeded to build in Pittsburgh for its own use the transmitter (later called KDKA) which broadcast the first regularly scheduled public programs. Later, the Bell System built WBAY (subsequently called WEAF) atop what is now the Bell Telephone Laboratories Building in New York City and at the opening in August, 1921, announced the company's intention of inaugurating "toll broadcasting," a significant term and a policy of far-reaching consequence.

Day after day, short talks, phonograph records, and player pianos were heard from WBAY, and a sales force was organized to solicit prospective clients with enough courage and resources to try a new medium of advertising—toll broadcasting.

Although special inducements were held forth, clients refused to patronize the Bell Company's commercial broadcasting facilities until Aug. 28, 1922. Then the Queensboro Corporation, a realty firm, purchased 10 min. of time for the sum of $100 and thereby led the way for others. This broadcast took place only 12 days after the call letters WEAF were heard on the air for the first time and a few months before the station had moved its studios from their location in the building at 24 Walker Street to 195 Broadway.

The growing prestige of the live-talent entertainment on WEAF and later on WJZ, then a Westinghouse station, in Newark, N. J., aroused some speculation on the part of New England station owners, which resolved itself into a query about the possibility of "importing" a program from New York. Of course, to the Bell Company this implied the use of telephone facilities, which appeared to be adequate for transmitting a program for a distance of several hundred miles. Subsequently, the staff of WEAF arranged a program of substantial merit, probably not realizing the historic portent of the day on which two radio stations were linked by a common circuit, initiating multiple-unit broadcasting, now called "networking."

On the night of Jan. 4, 1923, a small group of performers assembled in the main studio of station WEAF, on Walker Street, New York, and awaited the signal that would begin the first network broadcast, made possible by a telephone line between

New York and the transmitter of WNAC in Boston. Devora Nadworney, prize winner of the National Federation of Music Clubs, became the first network entertainer when she sang the "Habanera" from "Carmen." Others on the program, which lasted more than an hour, were Nathan Glantz, saxophonist; Arthur Wilde, cellist; Arthur Klein, pianist; and Raymond Freemantle, baritone.

When that first network broadcast took place, public interest in radio was keen, and the nucleus of today's large industry already existed. There were 1,500,000 radio receivers in the United States. Twenty-seven "fan" and technical magazines were on sale. Six hundred independent broadcasting stations served the listeners. Twenty-five hundred firms were in the business of manufacturing receivers and other apparatus.

At once, the WEAF-WNAC broadcast showed the convenience and practicability of a network; furthermore, it paved the way for the next logical step—the formation of a network with member stations linked together on a permanent or contractual basis.

On July 1, 1923, WEAF and WMAF at Round Hills, South Dartmouth, Mass., were connected for the summer by telephone circuits. On Independence Day, 1923, WCAP, Washington, D. C., owned by the Chesapeake & Potomac Telephone Company, was joined to WEAF and WMAF. The following fall, WJAR, Providence, R. I., joined the hookup while WMAF was disconnected until July 1, 1924. The arrangements proved so successful that by 1925 the WEAF chain was expanding rapidly into a national institution with the characteristics of a modern network. On Oct. 14, 1923, WEAF and WJAR, Providence, R. I., completed a plan for setting up the first commercial network, which went into effect immediately. About that time, the Radio Corporation of America entered the broadcasting picture by purchasing WJZ of Newark, N. J., from the Westinghouse Electric & Manufacturing Company.

The economic maladjustment of broadcasting at this time was a harrowing problem. Some people believed that an extensive program network would solve it and studied the Associated Press and United Press methods of syndicating news to paying clients, but finally they were convinced that broadcasting would have to obtain revenue on an entirely different basis from that employed by those two organizations.

The potential profits of broadcasting were clearly manifest between 1923 and 1926, and the broad principles of networking that were laid down from 1920–1923 showed that the pioneer thinkers in the industry had not erred in their judgment that a national broadcasting service originating from a central station was the key to economic stability.

At length, in 1926, the Bell Company disposed of its holding in WEAF to RCA, which organization formed NBC. Thus, RCA acquired the management and heavy responsibilities of operating a network.

The universal public approval of the service rendered by the Red network soon after its organization created a demand in various parts of the country both from listeners and from radio stations for equally high-grade program service from a second network. Inasmuch as NBC was the only organization then supplying network service, it met this demand by establishing the Blue network. It was organized to provide service of a comparable kind and quality to that offered by the Red network. A general programing policy was established of offering a diversity of programs as between the Red and Blue networks at any particular moment, thereby giving to the listeners in any particular section of the country a choice of two network programs and making available to them the kind of entertainment or educational programs best suited to their moods.

In operating television, NBC can project program standards that have been built up, based on operating experience, from 13 years of network broadcasting. These standards are based on the public interest, convenience, and necessity as laid down in regulations issued by the Federal Communications Commission. They cover such phases of broadcasting as the preservation of free speech, and presentation of both sides of controversial subjects in politics, religion, and current topics. There are restrictions designed to present all programs with good taste and due recognition that they serve an audience of all ages and of every degree of culture, education, and interest.

The networking of sound broadcasting provided an economic means of dividing the cost of a radio program among several units, making possible the fine programs of today, the talent costs of which may run as high as $25,000 for a single hour. Obviously, no single station could afford to give to its listeners

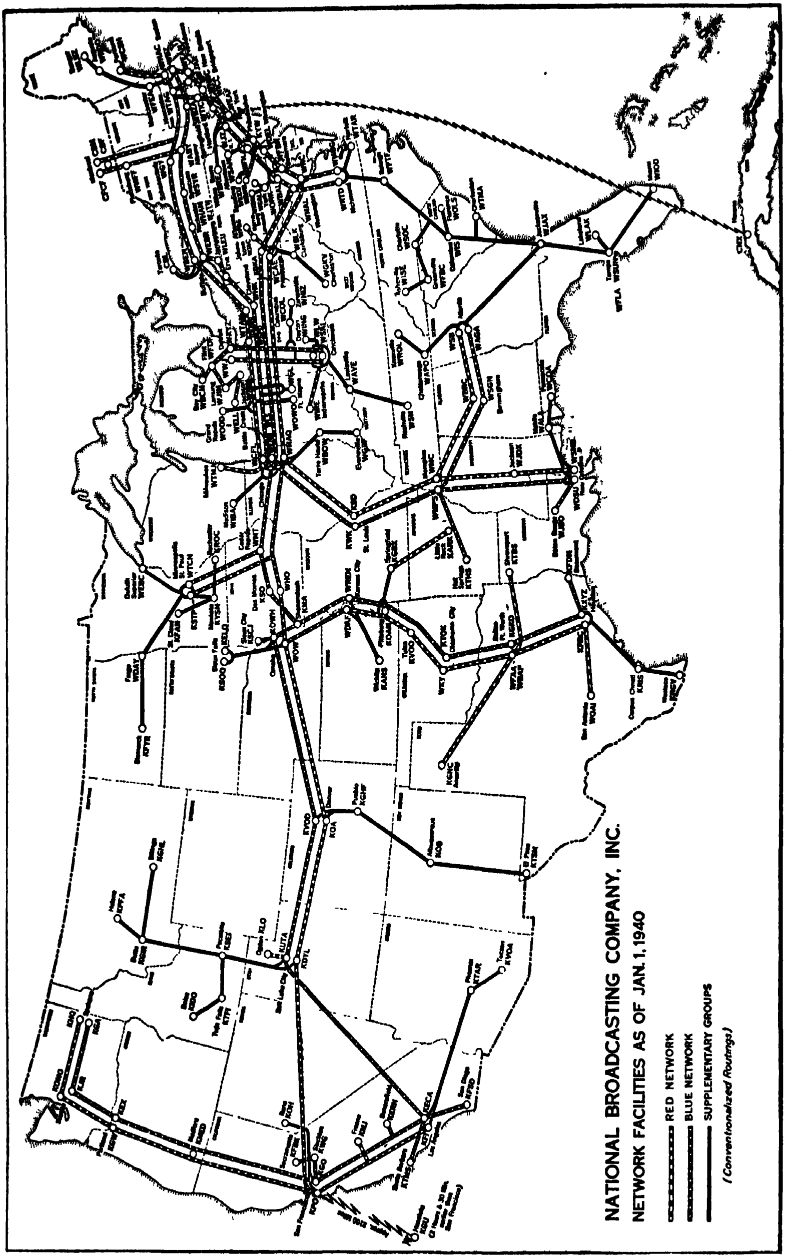


FIG. 54.—Network lines of NBC.

such expensive offerings. But even if the money were available, it would not be possible for a single station to provide the talent. The major talent centers are New York, Hollywood, and Chicago, and star performers rapidly gravitate to these points, so it must be here that the main studios of the networks are located that they may give this talent to stations scattered the length and breadth of the land. Not that most cities do not have excellent talent available locally to them, in some cases superior to that put on at the main centers. The real problem is how to provide high-quality programs 18 hr. a day, 7 days a week.

Moreover, the covering of special news events such as the sinking of the *Squalus* or foreign incidents such as the Munich pact in 1938 require many crews strategically located to bring these to the network. If these reasons were sufficient to produce networks for sound broadcasts they will be even more important in television. This is because the expense of programing is even greater than in sound broadcasting and the difficulty in finding acceptable talent is much greater, for the talent will have to have not only the same acceptable voice but, in addition, appearance and acting ability.

Sound broadcasting had the advantage of hundreds of transmitters already in existence before the first network was conceived. The sound-broadcast station could, in the early days, start on little capital. On some wave lengths, a few hundred dollars' worth of technical equipment sufficed. Records, a piano, and a few soloists offered comparatively inexpensive means of programing. The engineer was required to be licensed by the Department of Commerce. Commercial stations licensed on preferred wave lengths were required to meet more exacting requirements. But the television station, even to get the simplest program on the air, must begin with far more expensive equipment and requires the service of a number of thoroughly qualified technicians. Because of the initial expense and that of operation, television transmitters may be restricted to communities as large as 100,000, of which there are less than 100 in the United States. Thus the haul between transmitters will be relatively long and expensive.

From the foregoing résumé of how the first sound networks got under way may be deduced the probable development of a sight network. Let us first compare the early events of sound

broadcasting with those of television to date. Even a casual examination shows that television programs by no means parallel the relatively smoother route of radio. Sound broadcasting expanded at a much more rapid pace than can be anticipated for television. The financing of a radio station was so easy in the 1920's that within 3 years after the first broadcast from KDKA, 600 independent stations were operating in the United States. It is difficult to conceive of a similar growth for television, whose economics are more baffling and whose initial costs and operating problems require greater resources.

The phenomenal development of sound broadcasting, accompanied by the growth of networks, was influenced by such unusual circumstances that a comparison here may be inadequate. But the reasoning and motivation for sound networks that prevailed between 1920 and 1927 may be applied to the development of television with equal, if not greater, emphasis. Among the positive influences is a definite demand for the stimulating entertainment, culture, and information that a network of television stations could purvey to listeners at a reasonable cost. By virtue of its direct appeal, combining sight with sound, television must be rated an advertising medium of a high order, meriting increased outlays by clients who want to promote their products to the best advantage.

When television stations spring up in outlying cities, as undoubtedly they will, there will be a persistent demand among them for a program service designed to reduce operating expense and to offer a wider variety of entertainment. This television-program service may be even more vital to the individual success of the stations than sound-network service has been to sound broadcasters. At the same time, while reducing their costs, the associated network stations will be treating their respective public to the sight of famous personalities, news events, experiments, exhibitions, etc., that would not otherwise be available to a local audience.

The major departures from sound-networking history and practice that must be recognized while discussing a television network may be stated as follows:

1. The lack of existing wire-line facilities or radio-relay stations for connecting stations. This lack must be overcome before true network operations can begin.

2. It is self-evident that a television studio plant, to act as a network headquarters, must be considerably larger for a given number of program hours than a sound-network plant. The present rehearsal ratio to time on the air in television varies from 10 to 20 to one with experienced talent. A superproduction would require even more rehearsal time.
3. Since no present plan contemplates a complete coverage of the nation with television, it follows that sparsely populated regions will receive the service after the more populous zones. Population density and regional characteristics must determine the size and location of each network. The regional plan of networking, first proposed about 1921 and employed to this day, may provide a basis for sight networking.

One can scarcely entertain a hope of having coaxial cable networks as elaborate as the land-line telephone circuits now used for sound systems. Installation for a single trunk-line coaxial cable from New York to Hollywood is estimated to cost in the neighborhood of $20,000,000. If developments can be foreseen correctly, the first regional networks will spring up along the Atlantic seaboard, between Washington, D. C., and Boston, with New York strategically situated to service them. Here many large cities, spaced at relatively short distances, offer a concentrated audience.

In the Hollywood area, the Don Lee Broadcasting System has been experimenting with television broadcasting, and recently acquired a new transmitting site on top of a hill overlooking the surrounding country. It is to be expected that television activity will spread from Hollywood along the Western coast, just as it will spread from New York on the Eastern coast. In the Chicago area several broadcasters have filed applications for licenses and Zenith Radio is already operating.

As mentioned in the first chapter, NBC has completed initial plans with the General Electric Company in Schenectady for a direct radio hookup from the NBC Empire State transmitter in New York City to the GE transmitter on Helderberg Mountain in the Schenectady area.

The recording of television programs on film may become an integral part of building and servicing a network system. With a central library of dramas, newsreels, lectures, travelogues, and

documentary films on hand, it would be possible to carry on the vital functions of "networking" even prior to the operation of coaxial-cable and radio-relay links. The simple procedure of circulating moving pictures, whether specially made for television or not, offers a source of program material prior to the advent of interconnections.

For local consumption, films also have interesting possibilities. A camera crew could be assigned to "shoot" a spectacle, sports

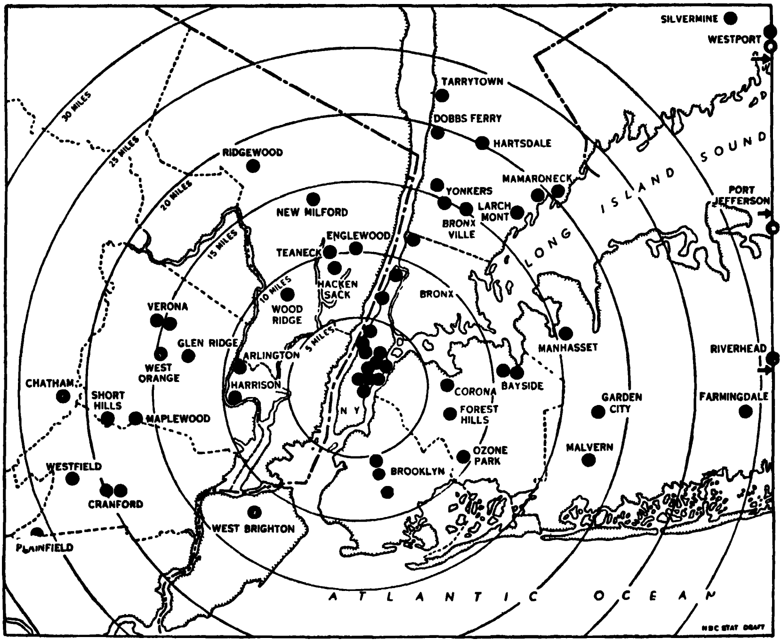


FIG. 55.—Television "coverage" in the New York area in middle of 1937. Each dot is one receiver—the receivers were in the homes of NBC-RCA company officials and technical personnel.

contest, disaster, parade, or similar news event, and the resultant film could be developed and televised with such speed that the pictures would arrive in the community homes within a few hours after the event had occurred. If a given event had regional importance, prints of the original film could be distributed rapidly by airplane, express train, or speedboat. This by no means includes all the possibilities of film syndication.

Another possible method of servicing a television network is by reviving an almost outmoded institution—the traveling stock

company. This would mean the employment of acting troupes which would acquire a repertoire of plays, sketches, vaudeville acts, etc., in central studios, whence they would travel to a "network" circuit of associated stations, presenting what would correspond to a repertory series, playing in each city for a week or perhaps longer.

It would not be necessary for these troupes to carry much cumbersome scenery and props, since each of the associated network stations could be permanently equipped with standard sets One considerable advantage of the traveling-troupe plan is that it would give a "live" program service to outlying stations whose studio space is entirely inadequate for elaborate rehearsal schedules, besides effecting other economies. In the long run, the troupe most likely to harmonize with a scheme of television networks would be the one with the widest assortment of individual and collective talents and the richest repertoire.

Just as films and performers may be sent from station to station, so may scripts, properties, and special effects be syndicated for use by local-talent groups.

Complex and remote as the nation-wide networking of television stations may seem today, its intrinsic merit indicates that ultimately it will be realized.

CHAPTER IX

BASIC ECONOMIC FACTORS

The economic basis of a television broadcasting service is an income sufficient to meet the expenses of the service and in addition provide a reasonable return on the investment. In the present state of the art, there is no direct income to the television broadcaster, and the expenses are great. Under such circumstances, the justification for establishing and maintaining a television-program service is that of investment in the future or desire to advance the art or as a supplement to some other agency such as a newspaper. It has been deemed wise by several companies to divert increasing amounts from their funds to the establishment of a television service. There can be little doubt of the wisdom of this course. Television, in the long run, is inevitable.

But the extent to which the major broadcasting networks, as well as individual station owners, should invest funds in the new art cannot be answered without a study of the costs, which include the prior investments made during the development of the system as well as the cost of studios, cameras, transmitting equipment, operating personnel, performers, performances, and service facilities. Against these costs must be balanced the income derivable, now or eventually, from the system. When the income exceeds the costs by an amount sufficient to cover the prior investments, then a firm economic basis for the system will be established, and television's most pressing problem will be solved.

It is obvious that the answers to these questions cannot be prophesied with accuracy so early in the development. Too many subsidiary questions remain unanswered. Too few organizations have operated a television system to obtain truly representative bases of cost. Television transmitting equipment at present is being produced as individual units; consequently, the prices of the present day may not be representative of those of

later years, when the production volume increases. Even the remuneration of specially trained operators and performers cannot be settled justly on the basis of present rates of pay. Well-trained men are required for the operation of a television system, and such men have been obtained by very careful selection from within the ranks of the radio industry. As television stations become more numerous, it is difficult to know if the supply of such men will keep up with the demand or, as has happened before, if too many will be intrigued by its promises. If progress is to be made in solving the economic question of supporting a television service, these uncertainties must be clearly understood in reading what follows in this chapter, since the figures quoted and the reasoning applied to them are based on limited experience.

Conservative estimates, made by competent observers in the field of radio economics, indicate that the present investment in the development of television in the United States exceeds $15,000,000. The field tests of the RCA-NBC system alone, extending over a period of more than 2 years, cost $2,000,000. Prior to these tests, many years of extensive research went into the development of the Iconoscope and Kinescope tubes, as well as of all the other elements necessary to the system. Other companies have made substantial investment.

With a $15,000,000 debt already contracted, it may be years before any of this investment will be regained through the operation of the television service. But the situation is not so serious as it may seem. The investment has been spread over a large number of items, a considerable portion having gone into the development of television equipment. Through the manufacture and sale of various kinds of television apparatus such as receivers, studio equipment, and transmitters, the industry can eventually recover a very large portion of the development costs which have been accumulating. Furthermore, the result of work on television development has produced equipment that will find important uses in disassociated fields and in various other branches of radio.

The prior investments that may be fairly allocated to the development of television programing may run into millions of dollars. The means of retiring this investment cost lies in establishing the service permanently in the affections of the listening and viewing public, because then, and only then, will

the sale of television-advertising time command a rate high enough to meet the prior and current expenses.

In other words, if television is to be successful, it must have mass acceptance. Mass acceptance, however, can be brought about only by the low prices that come with mass production of receivers, coupled with technical and program excellence. Program excellence is a problem of stable financing by the broadcaster. The broadcaster, in turn, must look to the advertiser for financial support of television; and the advertiser, finally, will have no interest in television until it has achieved mass acceptance. Here is an endless chain of interdependence. Apparently, there is no way of breaking through it at any point; the only solution seems to lie in slowly enlarging the chain, link by link.

The first necessity, with television receivers on the market, is a program service of satisfactory quality and regularity. Few people will buy a receiver just for show purposes or for the novelty of it; they must have pictures to look at and sound to listen to. It is the broadcaster's job to see that interesting programs are on the air.

In projecting our estimates to the day, certainly not many years distant, when television broadcasting service will rise to many hours a week, we find that an adequate studio plant, built on low-cost land and fully equipped with television and auxiliary equipment, may entail an outlay of several million dollars. Although these costs may appall the reader, they are wholly justifiable when television service attains mature stature.

The costs involved in programing a station, once it is ready for service, are less easy to predict. Now that it is technically possible to interconnect transmitters, we cannot continue to assume that television will be a strictly local operation. Hence out-of-pocket costs during the remainder of the development period must take networking into consideration. To operate a television station at all requires an operating crew for at least one shift. Under any program service, the cost of the operating crew is a definite minimum.

Technical operating and programing constitute the principal items of expense in television. To gain some conception of the probable television costs of the future, the television staff of NBC made a detailed analysis of each of three successive steps

in the new art. Every item, from the first actor to the last engineer, and from a new building to a can of paint, was listed, together with typical and possible programs and their costs for every period of operation during the broadcast day. This analysis serves to keep a close check on expenditures, and as a constant guide both to present operations and future planning.

A program service can cost all that the operator has to spend. There is a wide variation in the cost of individual programs even of the same length. All the ingenuity of the broadcaster will be called upon to present the most interesting programs at the least possible expense.

All this indicates a heavy drain on the financial resources of the broadcaster. It also points out the necessity for the broadcaster to expand his television facilities in step with the manufacture and distribution of television receivers. If broadcasting lags behind set distribution, the progress of the art will be retarded accordingly. To expand the broadcasting service far beyond the needs of the number of receivers distributed would be to invite an unnecessary financial drain.

The duration of tax on the broadcaster's purse depends directly on the rate at which receivers are manufactured and distributed. Accordingly, those who purchase television transmitters and studio apparatus should be informed on the probable operating costs and the time likely to elapse before enough receiving sets can be distributed in the area under consideration to produce sufficient income to cover operation expenses. They should be certain that they can afford the financial drain in the period of years before television broadcasting becomes self-supporting. Some who have lacked this foresight may unfairly blame their failure on the slow acceptance of television by the public, instead of the fact that they have not appraised the situation accurately.

To shorten the period during which television broadcasting is conducted at a loss, it becomes highly important that a large number of receivers be distributed in American homes. It is at this point that the manufacturer's policies with regard to television become vitally instrumental in the success of television. If the manufacturer fails to build satisfactory receivers, for sale at reasonable prices, the progress of television may be seriously retarded

Evidence that the radio-set manufacturers are fulfilling their obligation to television is, even thus early in the game, very encouraging. At the opening of public service on Apr. 30, 1939, three brands of receivers were actually available in retail outlets in New York City, there were three different construction kits available to amateurs, and, more significant, no fewer than 18 manufacturers had announced their intention of making television sets available to the public at an early date. In the first month of public service, interest on the part of the manufacturer grew, and an additional number of manufacturers announced their entry into the field. This is evidence that television has been accepted in the radio industry.

While the advent of television was expected by many critics seriously to affect the sale of sound receivers, such has not been the case. In the year 1939 when television was publicly introduced in New York City by RCA and NBC, sound receiver sales exceeded those of any previous year in the history of the industry.

Many dealers used television as a "come on" because it attracted new interest in radio. While ultimately television receivers may furnish a complete sound and sight instrument, present-day sound receivers will retain a full life usefulness.

The prices of the receivers were admittedly high. They ranged commonly from \$175 to \$700 in the early months; at the time of writing there seems to be a trend toward reduction of them. A price of \$125 to \$250, is within range of many families whose income is less than \$2,000 a year, but such families are reluctant to part with so substantial a sum unless there is reasonable assurance that the receiver will not become obsolete rapidly.

This question of the cost of receiving sets is the basic factor in obtaining "mass circulation" for the broadcaster. The necessarily high cost of the receiver—the technical equivalent of about three first-class broadcast receivers—cannot be reduced without painstaking effort. However, assembly-line methods, a supply of used receivers, and the effect of competition in bringing down the cost of television sets may be counted on to make sets widely available in the not-too-distant future. The problem is, of course, to market the receiver at a price within reach of a large number of buyers, to gauge the market accurately, and to keep factory capacity geared to the demand for receivers.

Here it is essential to note that indiscriminate scattering of television receivers is altogether out of the question. Where the receiver is sold, programs must also be available. And for this reason, the distribution of receivers must follow closely the establishment of television stations in the successive markets to be opened. At this date, there are a number of applications before the Federal Communications Commission for licenses to erect and operate television transmitters. When they are granted, service will be available in key markets.

Financing receiver sales is an important aid in developing the market for television sets. The present financing facilities used by radio retailers appear to be adequate and well enough organized to handle a considerable amount of television business. Installment buying also will be an important element in developing the market, once television gets into its stride. The more liberal the time payment the easier the purchase of a receiver will be for the consumer, and the more security he will feel against rapid obsolescence. Flexible financing will bring in many "marginal buyers" who otherwise would have to wait and hope for a more favorable proposition at some later time. Well-reasoned financing plans can absorb many of the features of a rental-distribution method without incurring any of the system's awkwardness and expense.

At least one company which has offered television receivers for sale in the New York area during 1939 and the early part of 1940 at prices ranging up to $600 has reduced their scale to range proportionally up to $395. In this present instance, they have offered to refund the difference between the earlier purchase price and the revised prices to those who acquired receivers before the price reduction. Under the revised schedule the price range is from about $150 to $395. A number of the sets offered provide a multiple-band sound receiver, as well as the television receiver, in a single cabinet.

The combination of radio and television receiver also attracts the prospective purchaser who may fear buying a sound set because of the imminence of television. Since the cabinet and much of the sound equipment are common to both, a definite saving is effected.

Another general consideration in connection with receiver distribution is the actual records of the television audience as it

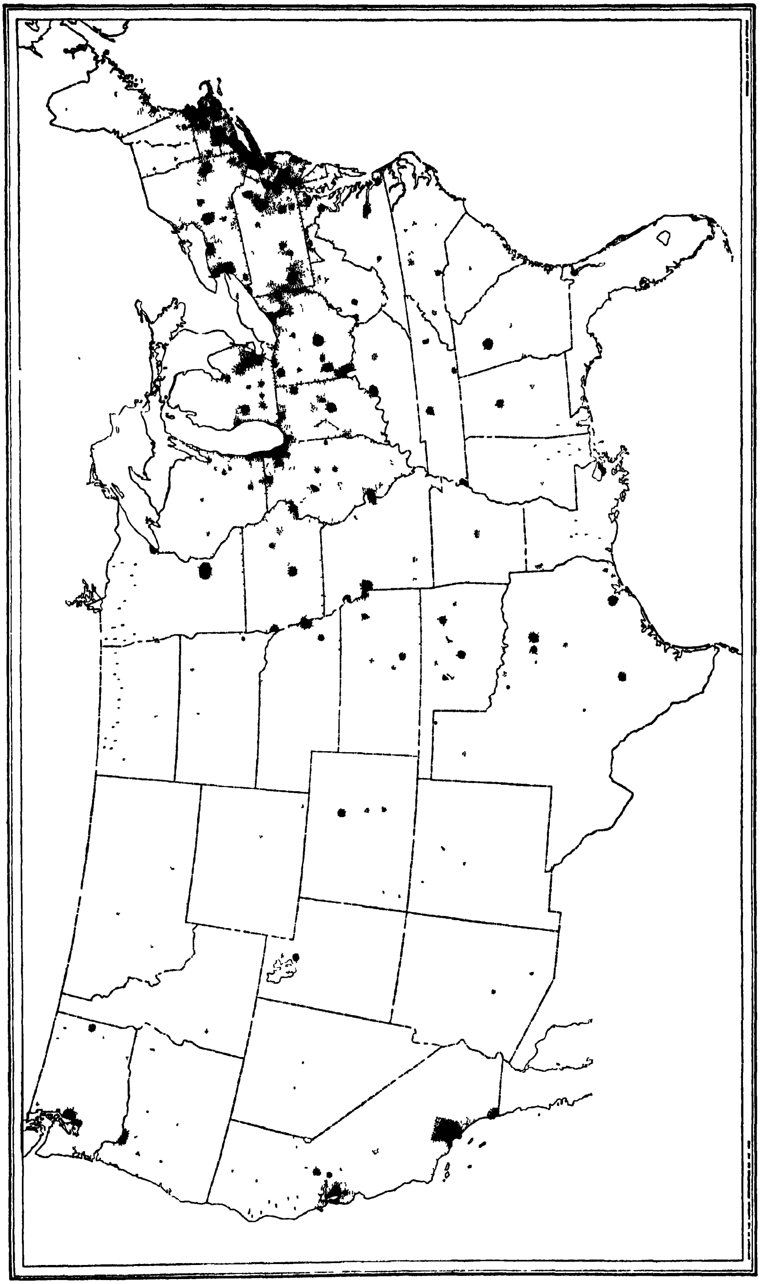


FIG. 56.—Map showing the relative distribution of population of the United States. According to the 1930 census, there were 96 metropolitan districts of 100,000 population or more.

develops. An accurate tabulation of all television purchasers, covering their location and the economic status and classification of family members, is valuable information to broadcasters and advertisers. Such records have been kept, at least in partial form, since the beginning of public service. Aside from the obvious commercial value, such data are of value also to broadcasters in formulating program policies.

Sales areas for television receivers must be governed entirely by the distribution of television transmitters. The limited range of television transmitters also definitely limits the extent to which the entire country can be considered a television market. As far as we know today, a television station's range for consistent reception of high-quality images extends over a radius of about 25 miles and, under certain conditions, to as much as 50 or more miles. The range depends mainly on the transmitting- and receiving-antenna heights, the power of the station, and the character of the terrain over which transmission takes place. The vast majority of the sound-broadcast stations of today have an effective range no greater than this, but it must be recalled that many listeners unable to hear local stations satisfactorily may hear distant clear-channel stations, especially at night.

It is to be expected that the distribution of the television transmitters doubtless will follow the general pattern of population distribution in the United States. This population may be considered as centered principally in 96 metropolitan areas set up by the Bureau of the Census having 100,000 inhabitants or more. These districts, in addition to the central city or cities of 50,000 or more inhabitants, include all adjacent and contiguous civil divisions having a density of not less than 150 inhabitants per square mile. They also include, as a rule, those civil divisions of less density which are directly contiguous to the central cities or are entirely surrounded by minor civil divisions that have the stated population density of 150 inhabitants per square mile. Suburbs, from the standpoint of broadcasting, are as much a part of a city as the area that is under municipal government. Throughout these metropolitan districts, there are usually unit services of telephone, water, gas and electricity, retail-store delivery, commuting service, newspaper and mail delivery, operation of local real-estate companies, and soliciting and collecting routes.

These 96 metropolitan districts are usually taken as the basis of marketing plans. Although they comprise only 1.2 per cent of the land area of the United States, they contain 45 per cent of its population. Assuming the maximum service area of a television transmitter to be 25 miles in radius, however, we find that 96 such transmitters (one in each metropolitan district of the United States) would lay down an adequate signal over 6 per cent of the land area and more than 50 per cent of the population. This affords a wide margin of safety against future population movements in, or enlargements of, metropolitan areas.

All 96 metropolitan districts cannot inaugurate regular television services at the same time. There are many obvious reasons for this, among them lack of transmitting facilities and the wisdom of the policy of testing results in the key cities first.

To choose an obvious example, New York is the first city of the United States to have regular television service intended for the public. The metropolitan district surrounding New York comprises 8.9 per cent of the nation's inhabitants, 63 per cent of the population of New York state, 72 per cent of New Jersey's inhabitants, and 9 per cent of Connecticut's. Chicago's metropolitan area includes 3.6 per cent of the population of the United States and 57 per cent of the inhabitants of the state of Illinois.

In some cases, however, factors other than population will intervene to influence early operation. Some of these markets already possessing experimental television transmitters, such as Iowa City, for example, are nearer the starting mark than they would be if purely economic factors prevailed. In other instances future station interconnection, or network, possibilities will determine the time a particular market first embraces television.

In general, however, the expansion of television service should follow along lines indicated by population. Much calculation and reference to the pattern of distribution followed by other commodities and services lead to the belief that the 96 principal market areas of the United States will be served with television within 10 years after regular broadcasts became available in New York City. Although there is no direct means of determining the number of receivers that will be sold from year to year, it is possible to resort to economic analogies, *i.e.* products and services falling in the same general class with the television receiver. In

charting the future of television, the histories of many other similar commodities were studied.

Those upon which the staff of NBC has based estimates are electrical refrigerators and radio receiving sets. Among other points of reference were population distribution and income distribution. All these were tempered with considerations, as judicious as possible, of the probable fall in receiver prices and the growth of a market in used sets.

Sales increase slowly at the beginning of the period, gather momentum, and then sweep upward, following which the curve of distribution tends to flatten, and the industry's growth follows general economic expansion of the country.

The sales figures on electric refrigerators and radio receivers bear out this analysis. For radio receivers, the figures are:

Years	Sets in use (as of Jan. 1)	Radio families
1922	100,000	100,000
1927	6,000,000	6,000,000
1931	14,100,000	14,000,000
1935	23,100,000	19,000,000
1938	37,700,000	26,700,000
1940	44,000,000	28,000,000

For electrical refrigerators, the cycle of growth to the point of stability has not yet been completed:

Years	Units in Use (as of Jan. 1)
1928	755,000
1930	1,850,000
1933	4,300,000
1936	7,250,000
1940	13,701,000

A careful analysis of the figures given above might possibly bring one to the comparative conclusion, obviously highly conjectural, that television receivers may be distributed nationally in the 96 markets to the extent of about 12,500,000 units by the end of the 15-year development period. Thereafter, development will be slower. It is hazardous to put too much credence in these figures because of one's inability to foresee all the

developments which might accelerate the progress of the art very rapidly (as did the advent of the a.c.-operated receiver and the dynamic loudspeaker in radio receivers). It must be remembered that 15 years is an extremely long time in the development of devices in the field of radio engineering. Nevertheless, the figures given above, on their face value, are encouraging. They indicate that a period of several years requiring a fairly heavy investment is ahead of the industry but that energetic and far-sighted companies who enter the field early and plan wisely will enjoy just returns well within the conventional maturity period.

The third aspect in the development—the rise of the broadcaster's income, enabling him to carry on regular service—is still an unanswered question.

The rate at which television broadcasting becomes a profitable investment for advertisers depends, primarily, on the rate of receiver distribution. In other words, the larger the number of receivers in a given market for a given program expenditure the lower the cost for each television viewer and, therefore, the greater the potential return for the investment in television advertising. Radio gives some clue to the number of receivers necessary to justify expenditures on television advertising.

There are today 28,000,000 radio families in the United States, many of which have several receivers including those in automobiles. If the expense of television broadcasting were equal to that of radio, if there were the same number of television receivers in the market, and if television had the same, or more, audience appeal, then television would certainly be a profitable investment for the advertiser.

The factors, however, are not identical for radio and television. To compensate for the added expense, television will have to be at least three times as effective a selling medium as sound broadcasting. On this basis an advertising situation for television as profitable as that in radio broadcasting would need only about one-third the number of television receivers in the market. If there were half as many, the advantage would lie with television. All indications, however, point to greater expense in television than in radio.

In the 15 years here considered, sound-receiver distribution will have approached much nearer to absolute saturation than

today. Perhaps a maximum of 35,000,000 radio families instead of today's 28,000,000 should be the one used in the comparison. In this case, the estimated 12,500,000 television-receiver total becomes about one-third that of radio sets.

But television receivers may become cheaper than we now believe possible, and a sizable market in used sets may develop in the early years of television to furnish units at low cost to many marginal buyers who could not otherwise afford to acquire a receiver. Then, too, methods may be found whereby television-broadcasting operations become less expensive.

It is impossible to set down precisely the day when the broadcaster will begin to reap profit from television, but the conditions that must be fulfilled before television can be profitable can be named: The balance of receiver distribution, the cost of programing, and the psychological advantage factor of radio must be measured against the same factors in television. When the balance tips in favor of television, the advertiser will find justification in setting it firmly on its feet.

CHAPTER X

THE SPONSOR IN TELEVISION

The American system of sound broadcasting is predicated on the sale of time on the air to advertisers, which provides revenue by which the extensive public service of radio is furnished without direct cost to the audience. Sound broadcasting has proved a remarkably effective advertising medium. Add sight and motion to sound—television—and a method is achieved affording not only the potent appeal of the human voice, the authoritative spoken argument, which is characteristic of sound radio; but the qualities inherent in graphic presentation—arresting attention, clarifying the presentation of an idea, and fixing an image in the mind. Furthermore, statistics suggest that the perception of the spoken word is heightened when the sense of sight is stimulated.

Why television emerges as a superior advertising method can be shown by a simple illustration. Let us say that the product is a breakfast food. In the television picture, the box is shown on the shelf and in a close-up, so a woman televiewer is made immediately and completely familiar with its appearance. She will recognize it anywhere, and if sufficiently impressed with the advertisement so that she wishes to purchase, she has only to point to the box on her grocer's shelf. Producers of packaged goods already know the value of attractive wrappers. What television will do to enhance this aspect of packaged-goods sales challenges imagination.

During the experimental period prior to the opening of a public service, the National Broadcasting Company made a number of experiments on commercial programs. They were done without audience for the benefit of the staff. Typical of these was one for Lucky Strike cigarettes. The scene opened with a theme-song background and disclosed a close-up of a small chair-side table on which an opened package of cigarettes was clearly discernible beside an ash tray in which a lighted cigarette

sent curls of smoke upward. A hand came into the picture and took a cigarette from the pack. It was unnecessary for an off-stage voice to say "Reach for a Lucky." The scene then cut to the deck of a boat, an exact replica of an advertisement that had appeared in popular magazines. The boy and girl who appeared in the cast were the professional models who had been used in the original photograph for the advertisement. They went through an interesting act in which the merits of the cigarette were adroitly brought into their conversation. This early experiment clearly demonstrated how the advertising appeal could be made to the eye as well as the ear.

But problems arise in connection, first, with the broadcasting of television for commercial ends and, second, with the employment of television by advertisers as a means to sell their goods. Before commercial television can be successful, "circulation," in the form of receivers distributed to an audience, must be built up in the major market areas. With circulation assured, advertisers should be willing to pay equitable rates for advertising time.

Since advertisers will be asked to foot the bills, they or their agencies will investigate thoroughly the sales potentialities of television. Short of such an investigation, a detailed picture of television's merits as a selling medium cannot be presented.

Before outlining the relationships and mutual benefits that may arise from commercial television, we shall discuss separately the factors that beget a desire both in the broadcaster and in the advertiser to have commercial television. For unless we can establish the fact that both these presumably interested parties desire television advertising, we cannot hope that it will materialize as a business. First, let us look at the broadcaster's side.

If sound broadcasters do not assume leadership in television development, it seems inevitable that other interests will. If the broadcasters of today divorce themselves from television, that will be tantamount to forsaking their superior position and jeopardizing their investments.

But it appears certain that for years to come, sight and sound radio will exist side by side. Hence the sound broadcaster embarking in television should be in a strategic position to benefit from the prestige of television operation. As the profits begin to appear, not only will these broadcasters find themselves among

the pioneers as television becomes a real revenue producer, but they will be in a position to adjust easily whatever changes television operation may bring about.

Most important is the cost structure of television broadcasting. Basic costs of television-program production will be high. Early operations, though unprofitable to all concerned, must be undertaken as an investment in profitable operations later on. These factors will prevent an overnight expansion of television facilities. But already television has made an impressive start, even without the benefits of commercial broadcasting.

Television serves special human needs and desires. It requires concentrated attention and cannot serve as a background for such activities as bridge playing or conversation. It is on this difference that many broadcasters base their belief that television will never replace sound broadcasting, but will supplement the present art with a more specialized service.

Fortunately, news about television developments is well adapted to publicity. Experience thus far indicates that television lends itself well to popularization and dramatization, and no one can gainsay its extraordinary power to sway and influence the thoughts and feelings.

In recapitulation, there are three main reasons why broadcasters have an opportunity in television:

1. Television should eventually yield substantial advertising revenue.
2. By promoting television, broadcasters maintain their supremacy in serving the home with radio entertainment, thus enlarging the value and scope of all broadcast advertising.
3. As the principal trustees of radio, the broadcasters are logically in a position to assume responsibility for the development of television; consequently, they feel more or less under moral obligation to establish television service.

The advertiser's advantage in supporting television must lie simply in the question of "good business." In deciding whether or not it is good business, the obvious yardstick is his experience with sound-radio broadcasting, especially in its beginning. It is well known that considerable prestige and, in many instances,

substantial profits accrued to advertisers who utilized the radio medium in the very early days. There are several different factors which contribute to making television a good business

FIG. 57.—The television unit of audience is the family circle.

buy for the advertiser from the beginning. Those that might be mentioned especially are:

1. Initially, television will offer advertisers a "class" market—because for a considerable time the price of television sets will continue to be high. Circulation will be concentrated in the richest market areas. The advertisement will reach the people who have money to buy, if the program itself holds their interest.
2. A television advertising message can be more effective than one in any other medium.
3. Early television programs will be received enthusiastically simply on the basis of the newness of the service, resulting in prestige and publicity to advertisers.
4. As a modern development dedicated to public service and popular enlightenment, television affords an excellent medium for institutional advertising.

5. Television commands active and concentrated attention from its audience. No part of its message is lost.
6. Psychological studies indicate that impressions received by television last longer than those received by means of other advertising mediums.

It is generally recognized that the urge to buy is set up by emotional stimuli playing upon the senses. In sound broad-

FIG. 58a.—A photograph of the parade of new automobile models in front of Radio City.

casting, "word pictures" are employed, but a voice, however persuasive, cannot possess the power of a picture vividly portrayed.

Much study has been given to what actually motivates the consumer to buy a particular product. The selling forces vary depending on many conditions, but certainly the emotional appeal is a high one, especially in competitive goods that are nationally advertised. The consumer learns that certain products are of good quality and are offered at a fair price. Any others that do not meet these standards would have long ago been

forced out of business, for only the successful ones can afford national advertising. But if the experience of the purchaser has been, in general, satisfactory with one product, claims of the technical excellence of another, although impressive, may leave the customer uninspired to buy.

It requires no salesman to prove that pancakes and sirup are good. Nor does the fact that the flour was made from hard wheat and ground to impalpable fineness make the mouth water.

FIG. 58*b*.—The same scene as Fig. 58*a*, photographed on the television screen.

Let us visualize the television appeal. A jolly cook is mixing some batter before the eager eyes of two hungry youngsters. Of course the package is in full view but in its normal place. The procedure continues. The batter goes into the frying pan and, with a flip of the turner, the cakes are turned in air. The children rub their tummies and dance in anticipation. The cakes are done, are dropped on plates, and covered with luscious sirup. The children ravenously devour them and cry enthusiastically, "Gee, they're good!" Simple and homely but likely to inspire in the viewer a desire to share in the children's pleasure and a

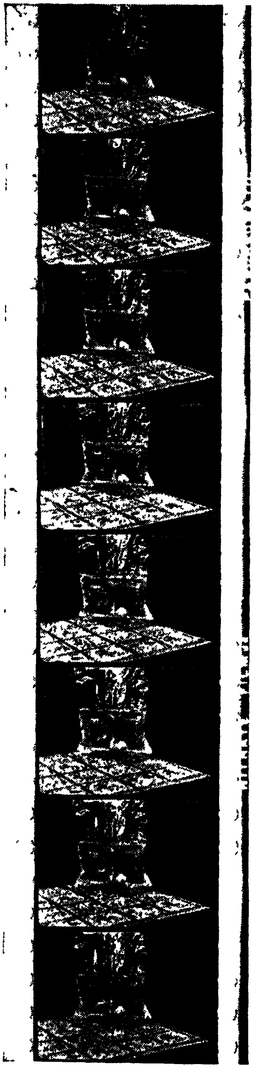


FIG. 59.—An example of commercial presentation by motion-picture film. A strip from a reel of "Teletopics" a series of NBC produced movie shorts. These frames show a cellophane carry-bag for goldfish.

motivation to action: "Mary, how about some pancakes for breakfast in the morning?"

A verbal statement that an automobile is the ultimate in safety may carry a certain amount of conviction. The same statement will carry real evidence of its truth when coupled with a television picture of the car hurdling gullies, riding up curbs, turning somersaults, and ending with the driver, very much alive, stepping out with a smile. Besides being thrilled and entertained, the televiewer will associate his emotional experience with that particular make of automobile. In the same way, the sight of prominent people admiring a car will create a favorable reaction, and a picture of the car will be definitely impressed on the televiewer's mind. The fact that the people are actually there and the events happening at the instant seen, with no third-party interpolation, should carry a conclusive conviction.

Similar examples as applied to other products could be multiplied indefinitely. The point is that television, like sound broadcasting, actuates the prospective buyer through his emotions and reasoning faculties—only much more powerfully. Many clever ways have been devised to promote commercial products on sound programs; but combine ear and eye stimulation, and the possible varieties of arousing interest are endless.

There is a trend toward visual advertising as for example the series of 10-min. motion-picture "shorts" produced recently in behalf of the Chevrolet Motor Company. Each short was built around an

interesting episode in which, incidental to the general action, a Chevrolet played a part. The sole references to Chevrolet were in the opening and closing titles and a final close-up of a car wheel coming to a halt and showing the Chevrolet trademark. It seems logical that if this firm found it worth while to pay for film shorts at about a thousand dollars per minute of

FIG. 60.—Commercial presentation by direct pickup in the studio. The scene shows a commentator demonstrating ladies' jewelry and "going away" knicknacks.

projection time—and to a limited circulation—other large advertisers would find it reasonable to spend similar and even greater sums for producing television programs that could conceivably enjoy much wider circulation.

There are three apparent methods for presenting television commercials:

1. Direct pickup from live talent, still objects, or outdoor scenes.
2. Motion-picture films.
3. Cards, diagrams, slides, etc.

All three methods can be practiced, with or without accompanying aural messages. The direct pickup implies the use of

actors, equipment, and props appearing in direct transmissions from studios or from outside locations. Set decorations, costuming, and dialogues may be worked into the presentation effectively, and the actual use or consumption of a product may be dramatized and demonstrated. Entertainment of sufficient merit to attract and hold an audience must of course be offered.

Movie films also may be used advantageously. Scenes showing manufacturing processes, machinery, workers, uses of the product, etc., can be taken and used as a complete show under some circumstances or as advertising copy under others.

With "still" presentation, photographs, diagrams, maps, and charts can be exhibited on the television screen, with appropriate descriptive captions.

Certain aspects of seeing bear on the so-called "advantage factor" in television. There is a definite difference between the audience-attention value of sound radio and that of television. To see a television program, it is necessary to remain stationary and watch attentively; whereas in radio, one may move about at will within range of the loudspeaker.

Regardless of how attentively people listen, sound radio has proved its salesmanship. This argues strongly in favor of television advertising, for television not only attracts listeners; it may conceivably convert many passive listeners to attentive "lookers."

Since the television receivers at present cost more than many buyers in the mass market can afford, a high-income-group audience is anticipated at first. The advantages of such circulation are clearly recognized; there should be no need of pressing an obvious point in television's appeal.

Despite these factors, it is quite likely that among the initial buyers of television time will appear those in mass-product classification. The reason may be found in the ability of the early advertisers to capitalize on the widespread interest in and curiosity about television. More than 10 years of speculation and discussion have helped to create suspense on the part of the public and to make people acutely television-conscious. Many people are waiting with varying degrees of eagerness for the experience of seeing television or of being televised. This public interest is an asset to the buyer of television for commercial use. Even if there are limited sales returns, the prestige of pioneering with television has real value.

What will television advertising cost? The question is most easily answered in comparison with cost in sound radio. The leading sound-broadcasting stations in the New York area sell commercial advertising time for the nighttime periods at an average rate of approximately \$1,600 per hour. The rate during the daytime hours is roughly one-half as great. There are, within the immediate area served by such stations, 4,000,000 radio families, *i.e.*, homes having at least one radio. Obviously, all those do not have their radios turned on at one time, and the figure represents the potential circulation, used because it is the only known constant.

Of those that are turned on, let us assume that 15 per cent will be listening to any one of the major stations, since the attention of the radio audience is divided among three other clear-channel stations and a larger number of smaller ones. Therefore, 600,000 radio families may listen to the one station, resulting in a unit cost for facilities of about ¼ ct. per family (\$1,600 ÷ 600,000). If we make the assumption that the program costs are equal to the cost of the facilities (which is approximately true for the majority of programs), the total cost is ½ ct. per radio family for nighttime (and ¼ ct. for daytime, with the same percentage listening).

For purposes of this discussion, let us assume that television is three times as effective a selling medium as sound broadcasting: (1) because of the novelty of the device; (2) because the cost of the receiver will put it in higher income class brackets; and (3) because of the stronger appeal possible with an auditory-visual message over just an auditory one.

On this premise, the advertiser could afford to pay 1½ ct. per television receiver for a nighttime program. By determining the cost of an hour (or fraction thereof) for television, we may find the number of television sets in the homes of the public that will make the advertisers' unit cost comparable to that for sound broadcasting.

Assuming the cost of 1 hr. on the air for television facilities and program to be in the neighborhood of \$2,000, there would have to be within the range of the Empire State transmitter a potential audience of 135,000 sets (\$2,000 ÷ \$0.015) to produce an equal return per dollar expended in television compared to sound broadcasting. However, experience indicates the fallacy of

accepting such analyses as anything more than mere indications of probable trends.

With the audience divided between two transmitters in the same area, it would require 270,000 television sets turned on and the audience looking at the programs. The Columbia Broadcasting System has erected a transmitter and has recently put on its test pattern.

In a discussion of television advertising, it is pertinent to bring up the question of the relationship of agency and broadcaster in the production of commercial programs. With the advent of commercial television, many prevailing customs in sound broadcasting are likely to be inapplicable. For instance, in making commitments to an agency, the television broadcaster must remember that the ratio between actual performance time and rehearsal time is an extreme one. It takes more time and work to prepare a television show than one requires for sound broadcasting. The contract for sound-broadcasting facilities which agencies sign with NBC entitles the client to unlimited rehearsal time, in addition to staff assistance. If clients are persuaded to present elaborate television productions, it seems advisable to have a detailed understanding regarding the use of studios, properties, scenery, personnel, and equipment expense.

Television presents certain aspects that have no counterpart in sound radio. A large part of the actual production is carried by a number of highly trained technicians who function in the studio with the actors and, operating on cues, become an integral part of the production. It would be uneconomical for each of the advertising agencies to have such an engineering staff even if it were available, and broadcast studios would probably not be willing to delegate responsibility for use of technical studio equipment. Hence, the bringing in of a "package" show by an agency, *i.e.*, a show for which the script, the actors, and musical numbers are assembled and ready for production, may present difficulties not encountered by sound broadcasting. Experience will indicate the proper relation of agency and broadcaster in the studio.

The studio audience, present at many sound broadcasts today and offering a desirable "plus" to the client, may probably be absent from the television studio. The cameras, operators, and other equipment and the overhead lights would block the view

either from the floor or from the balcony. However, the studio of the future is still to be visualized, and the foregoing discussion is in the realm of speculation.

Manufacturers have long known the desirability of getting their product into the purchaser's hands for a trial. Nearly equally valuable is a friend's enthusiastic endorsement. Television offers close approximation to these conditions. The article can be brought, by picture, right into the consumer's home and demonstrated for him where he will see with his own eyes exactly what it will do and have a sense of actually participating in the demonstration. The consumer will see the operation as it is actually taking place, carrying that conviction which induces a belief in the superior selling qualities of television.

At this writing, television transmitters are licensed on an experimental basis which definitely limits the extent of participation in the project by commercial sponsors. To gain experience in the production of commercial shows and to stimulate the interest and imagination of agencies and sponsors, NBC has offered an opportunity, without charge, for an advertiser to present an experimental show. By thus bringing the best advertising brains of the country into partnership, it is hoped that the art may be more rapidly developed. Altogether, during its first year of public operation, NBC has presented 227 client-cooperative programs, representing 95 different national and local advertisers in 28 different industrial classifications. A few of these, notably Lowell Thomas, have been telecasts of regular sound programs.

In using the term "commercial broadcasting," a number of different definitions are possible as applied to different stages of commercialization over a period of years, as follows:

1. A commercial show presented without charge on an experimental basis—the advertiser merely furnishing the talent.
2. The first advertiser who actually purchases time, perhaps at a nominal cost, and before circulation warrants the expenditure, for experimental purposes or for mention in other forms of advertising.
3. The first advertiser who purchases time on a regular basis as an economic means of selling his goods.

4. When sufficient advertisers have purchased time to meet actual out-of-pocket costs so that the broadcaster may break even on his operation.
5. When sufficient advertisers have purchased time at a price sufficiently high to amortize existing equipment and back costs, to pay overhead and operation costs, and to produce a reasonable profit.

These successive steps should follow with an indeterminate interval of time between them. The rate of progress will depend on how rapidly solutions to the economic problems are found. Moderate-cost receivers of high quality and reliability are the first consideration. These will be influenced by the growth of a nationwide market due to the installation of many transmitters and a public demand excited by program standards sufficiently fine to warrant the cost of the instruments. The excellence of programing and the number of hours of service per week, then become the questions of major consideration. As both of these are approached, mass circulation will be obtained sufficiently large to justify the expenditure of the advertiser's dollar, giving the broadcaster additional money to put on more and better programs, hence further promoting the sale of sets and accelerating their mass production. Thus the circuit is closed.

Many of the problems facing the television broadcaster today could be solved if he had unlimited funds at his disposition; but since he must conserve his resources so that he may continue to operate through the nonprofitable period, he must use every device to produce service at a minimum of outlay. Unfortunately, word has spread that the new industry will make millions, which eventually it should, and many performers and others who have something to offer have demanded exorbitant fees. This is shortsighted, for the broadcaster cannot afford them today; but unless the best of services are available, the time of profitable operation will be further postponed, and more years must elapse before those who have something to offer to television can receive large returns for their efforts. A reasonable understanding of the problem and fair cooperation from those interested will greatly accelerate television's progress.

CHAPTER XI

THE LEGAL ASPECTS OF TELEVISION SERVICE

It is the author's intention in this chapter to discuss briefly the practical aspects of the major legal problems encountered by the television broadcaster. Among these are the relations between television broadcasters and the government, rights in original and recorded program material, civil rights, relations with talent, and the relations between the broadcaster and the advertiser.

Television broadcasting constitutes one form of radio communication and, as such, is subject to regulation by the Federal Communications Commission pursuant to the terms of the Communications Act of 1934. Therefore, before a television broadcaster may operate a television station, he must secure a license from the FCC.

The commission has allocated definite portions of the radio spectrum to the various radio services under its jurisdiction, *e.g.*, point-to-point telephone and telegraph stations, geophysical survey stations, marine and aircraft stations, public safety stations, amateur stations and broadcasting stations including regular sound broadcasting, relay broadcasting, international broadcasting, high-frequency broadcasting, facsimile and television broadcasting. Nineteen channels, each of which is 6 Mc. wide, have been allocated to television broadcasting, making a total of 114 Mc., which is 38 per cent of the total useful radio spectrum available today for all services. Despite the large part of the spectrum devoted to television, the number of television-broadcasting stations in any given section of the country will be limited particularly because the channels in the upper part of the spectrum are not now effectually usable.

The FCC has established certain technical and financial standards required for a license to operate a regular sound-broadcasting station. It would be reasonable that, because of the more limited number of channels available for television and the increased public responsibility imposed thereby on operators of

television stations, the qualifications required by the FCC in judging the relative merits of applicants will be fully as high as those already established for sound broadcasting.

The FCC has the statutory right to prescribe, among other things, standards for type and character of television-transmitting equipment to be employed. These standards affect, much more so than in sound broadcasting, the ability of a television receiver to pick up programs. In sound broadcasting, once having established the general system, the fidelity of transmission may be increased by transmitting a wider band of frequencies than before without making it impossible for existing receivers to reproduce the program as faithfully as formerly. In the case of television, one means of increasing the clarity in the picture is while retaining the number of pictures per second, to increase the number of lines in it. How successfully this can be done at the present moment, without influencing the effectiveness of the receiver, is a matter of study by engineers at the time of this writing.

During 1939, after several years of consideration of the problems involved, the Radio Manufacturers' Association adopted a set of technical standards, and recommended their adoption by the FCC. A subcommittee of the FCC was appointed to study the matter and the Commission held hearings early in 1940 on the subject. Testimony of the witnesses made it obvious that there were differences of opinion within the industry on the question of standards, even though such specifications had been recommended by the RMA.

The attitude of the Commission in this matter was expressed in a document issued by it on Feb. 29. As to the adoption of technical standards, it stated in part:

Enough has been said to indicate the present state of flux of television and the fact that its progress still continues. The issuance or acceptance of transmission standards by the Commission, especially in combination with the more extensive experimental program service which will in all probability develop under these rules, would have a tendency to stimulate activity on the part both of manufacturers and the public in the sale and purchase of receivers for home use. It is inescapable that this commercial activity inspired and then reinforced by the existence of Commission standards would cause an abatement of research. To a greater or less extent the art would tend to be frozen at that point. . . . The Commission has not overlooked the significant sums invested by pioneers in making

possible our present knowledge of television, and it is not unsympathetic with their desire to recoup their investment in the process of bringing television's benefits to the public. It will be realized however, that the loss to the public by premature purchase in a rapidly advancing field might in a relatively short period exceed many times the present total cost of research. Such an economic loss in the long run can rebound only to the harm of the industry. In view of the apparent proximity of improvements and of the resolution of disputed technical questions, these risks should not be taken. The Commission is, therefore, reserving the matter of issuing standards for consideration at some future time.

The same considerations which demonstrate the unwisdom of the Commission's promulgating standards at this time dictate the undesirability of the industry itself attempting to impose such a code on all points. The Commission therefore recommends that no attempt be made by the industry or its members to issue standards in this field for the time being. In view of the possibilities for research, the objectives to be attained, and the dangers involved, it is the judgment of the Commission that the effects of such an industry agreement should be scrupulously avoided for the time being. Agreement upon standards is presently less important than the scientific development of the highest standards within reach of the industry's experts.

The Commission also stated:

Nothing should be done which will encourage large public investment in receivers which, by reason of technical advances when ultimately introduced, may become obsolete in a relatively short time. . . . Even now, there is no reason apparent why those members of the public to whom regular television programs are available, who are conscious of the fluid state of the art, and who are willing to assume the financial risks involved for the obvious benefits of current programs, should not acquire receivers.

Rules issued by the FCC after the January, 1940, hearings and under review as this volume goes to press, contemplate two types of stations. Under these rules, Class I or "Experimental Research Stations" would be authorized primarily to conduct research and experimentation in development of technical phases of the art; Class II or "Experimental Program Stations" would be authorized primarily to conduct research and experimentation for development of the art in its program phases.

If these rules are finally adopted, Class I stations would be prohibited from a regularly scheduled television broadcast service to the public, but Class II stations would be required to maintain a minimum weekly scheduled program service of 10 hr.

Under the rules being discussed at this writing, no stations could make any charges for production or transmission of tele-

vision programs before Sept. 1, 1940, when Class II stations would be allowed to make charges to cover the cost of programs produced for sponsors, but not for their transmission.

On Mar. 22, 1940, the FCC's order of Feb. 29, in so far as it authorized limited commercialization of television programs, was suspended and new hearings were ordered.

On the basis of these hearings the Commission on May 28, 1940, issued an order stating that no standards of transmission would be set for television until the engineering opinion of the industry could agree thereon and that until that time no commercial television broadcasting even of a limited nature would be permitted. At the same time, the Commission announced that the television band from 44 to 50 Mc. would be reassigned for the use of frequency modulated broadcasting services, and that in its stead there would be assigned for television purposes the band from 60 to 66 Mc.

In connection with the proposed reallocation of frequencies, all television licenses have been canceled as of Jan. 1, 1941, with the request that new applications be filed in accordance with the new allocation scheme. The Commission has announced the intention of taking prompt action on applications for experimental television stations and of granting them over a wide geographical area, with a limitation on the number of authorizations granted to any one licensee. It also announced that it will subsequently issue rules and regulations giving effect to the conclusions reached in its decision, but has not announced the date when such rules and regulations will be forthcoming (see page 266).

Now that television is becoming an established art, however, the relationship between the broadcaster and his government may seem to be the essence of simplicity by comparison with the numerous complicated questions that may arise in obtaining rights to make television broadcasts of various types of program material. It appears certain that television will eventually consume more material produced from the minds of authors and composers than any other entertainment medium.

The obtaining of rights in such material presents numerous legal problems which threaten to keep the legal representatives of the television broadcasters busy for some time to come. Television, having developed into a medium of popular entertainment both recently and suddenly, may find itself seriously hampered by the fact that many of the routine precedents

applied to the clearance of program material for straight aural broadcasting do not apply. It may be necessary to resort to legal proceedings in order to adjudicate some of the principles involved and to establish the television broadcaster's obligations.

The difficulty of clearing material for television broadcasting may be illustrated by an experience of the National Broadcasting Company. Recently NBC negotiated for the right to make television broadcasts of a series of motion pictures produced a number of years ago. The motion-picture producer who made the picture had acquired what he claimed was the complete right to use the motion picture in any way he saw fit. He subsequently sold the film to a motion-picture distributor, and in making the sale no specific restrictions were placed upon the uses to which the motion picture would be put. A question immediately arose as to whether or not the distributor had acquired the right to license the use of the film for television purposes. In the course of the negotiations for television rights to this material, it has been discovered that both the producer and the distributor possessed negatives of the film and furthermore that the distributor was in receivership. Counsel for the receiver was contacted, and he advised the company that the distributor did not have a clear right to license the use of the film for television purposes and that he could not therefore grant such rights. When the producer of the film was approached, he likewise stated that he could not grant television rights in the material without also getting the consent of the distributor who had rights in it. The result was that the only way NBC could obtain the right to broadcast the film was to obtain a license from both the producers and distributor and pay each of them a license fee.

Although it is not impossible to work out situations of this type, the difficulty of knowing in any particular case precisely what licenses may be necessary causes confusion and leaves the broadcaster in a rather exposed position. As television develops, it will require a great deal of program material, and to negotiate rights in each piece of material separately would not only add to the broadcaster's expense but also prolong the period of negotiation and make more difficult the acquisition of rights.

Furthermore, no matter how carefully a broadcaster examines a work that he proposes to broadcast, there is danger that it may be a plagiarism and infringe upon some previously produced work. Innocent infringements constitute a great source of

danger to television broadcasters. In recent years, a constantly increasing number of plagiarism actions have been started against prominent composers, authors, publishers, and users who in many cases have been completely innocent of any infringement. Some of the actions are undoubtedly well grounded, but it should be pointed out that writers are finding it increasingly difficult to write anything that does not leave them open to claims of plagiarism. Even though such actions may be defeated, they constitute a source of trouble and expense to broadcasters.

We foresee a period, when these rights are being settled, in which the broadcasters will be placed at considerable expense to assure themselves that they are not acting improperly.

NBC obtains both television and radio rights in material that writers create in the course of their employment by NBC. Up to the present time, therefore, the company has encountered no great difficulty in connection with the material written by its own employees which it is desired to broadcast by television. The rapid expansion of television broadcasting, however, may make it necessary to revise the agreements between the company and its writers from time to time in keeping with new developments.

Material written by other than NBC employees generally falls into three categories: musical material, literary material, and the embodiment of either or both in motion pictures.

In the musical field, the television broadcaster is interested in two types of rights, *i.e.*, the right to make nondramatic performances and the right to make dramatic performances of a composition. In the field of nondramatic performing rights, a conflict exists among a number of parties as to which controls the right to license nondramatic television broadcasts. One of the large music-licensing organizations claims that under its agreements with its members it has the right to issue such licenses to cover compositions that are part of dramatico-musical works (such as operas and operettas) as well as those which are not part of such works so long as they are written or copyrighted by its members. On the other hand, some of its members dispute the right of the licensing organization to issue such licenses. Also, owners of dramatico-musical rights, *i.e.*, the right to perform a dramatico-musical work as such in whole or in part, claim the sole right to license the making of nondramatic television performances of any individual composition contained in the larger work. So there is a conflict within the music industry itself over these

rights which must be settled either by negotiation between the parties directly concerned or possibly by litigation.

Three methods immediately come to mind by which the broadcaster can protect himself. Pending such settlement, he may obtain the originals of all the agreements entered into between the various parties claiming to control the television rights and reach his own conclusions as to who has the rights. He may accept a license from any one or more of the parties claiming rights subject to an agreement on the part of the licensor that he will indemnify the broadcaster against any claim made by reason of the broadcast. The broadcaster may negotiate licenses from all the claimants. All three plans are, however, open to some objections. The first possibility would obviously require a considerable expenditure of time, effort, and money in many cases, and there is no assurance that the broadcaster would place a correct interpretation on the agreements. The second suggestion would afford satisfactory protection only provided the indemnitor had sufficient assets to be responsible for any claims that might be made; and the third is subject to the objection that it would probably require the payment of separate fees to each of the parties claiming rights. It is possible, however, to clear rights in most of these cases, even though it will require some care to do so.

A similar situation exists in connection with the making of dramatic performances either of dramatico-musical works or of nondramatic compositions. The principal organizations from which the broadcasters now obtain the right to broadcast music hold the right to license only nondramatic performances. The dramatic rights are often scattered among writers, producers of plays, and, in many cases, motion-picture producers. Before making a dramatic performance of a musical or dramatico-musical work, the owners of such rights must be found. There is no single organization that controls and has the power to issue blanket licenses for the making of dramatic performances either of individual pieces of music or of operettas and other dramatico-musical works in quantities sufficient to supply the needs of broadcasters. It would therefore be necessary to obtain separate licenses covering individual works or small groups of compositions; the acquisition of such rights would require a special staff of trained employees and the expenditure of considerable sums of money.

The alternative to the somewhat expensive and cumbersome method of clearing each of these musical works separately is to limit the use of musical material to those compositions in which rights may be easily obtained. This course can be followed during the early stages of television, but eventually such a procedure would seriously handicap the development of programs.

In addition to the musical situation, the right to use literary material must be acquired. It has been held that the owner of a copyright in a nondramatic literary work has no right to prevent the reading of it in nondramatic form on a radio-broadcast program. The situation on television is somewhat analogous, and it seems likely that the courts may follow the decision as applied to radio, although it is an extremely technical one. This and other similar questions dealing with literary rights will have to be adjudicated eventually.

Often the television broadcaster will want to broadcast a dramatization of a nondramatic or a dramatic literary work. In order to do so, he must obtain a license. The right to grant such licenses depends entirely upon the contracts that exist between those concerned with the work. It may rest in the publisher or in the writer or, if a play has been written based upon the work, in the writer or the producer of the play. On the other hand, motion-picture rights in the work may have been sold, and television rights may have been transferred with them. As with musical works, a careful study must be made in each case to determine who has the rights, since no single organization controls a large enough group of television rights in literary works to permit the making of blanket agreements.

Here arises another interesting question. It is easy to define the term "dramatization," but it is very difficult to determine in many cases whether a proposed use of a work is a dramatic or a nondramatic one. The decisions do not draw a satisfactory line between these two types of performances, and it seems certain that there will be considerable litigation before the confusion over the definition of "dramatization" is finally dispelled.

Another great source of television-program material is motion pictures. A motion picture made by the regular commercial producers is copyrighted, and the broadcaster needs a license from the producer who is generally the owner of the copyright on the picture itself. Whether or not an additional license is

necessary depends upon the agreements made with others by the producer of the picture. The writers or owners of the works on which a motion picture is based may have retained television rights. This will be a common situation in the case of many of the older motion pictures, and in these cases two or more licenses may be necessary before the picture may be broadcast. It is also possible that the directors, actors, and other people concerned in the making of the picture may not have granted full rights to the motion-picture producer. In all recent motion pictures made for the purpose of exhibition in theaters, the motion-picture producers have probably obtained such rights which they can pass on to the television broadcaster; but in some of the earlier films, it may be necessary to study the agreements between the producer and his employees in order to make certain that the film may be used for television.

A further question arises as to what licenses the television broadcaster may need to broadcast the music incorporated in the motion picture. In many cases, writers of the music have assigned all their television rights in their compositions to others prior to the time they attempted to assign them to the motion-picture producers. In such cases, it is possible that the broadcaster may also have to obtain a license from the representative of the writer just as today a motion-picture theater must hold a license from the American Society of Composers, Authors and Publishers before it may safely exhibit a motion picture containing music written by a writer member of the society.

In regard to the use of motion-picture films, a recent court decision may have a profound bearing on the development of television. This held, in effect, that the exhibition of a motion picture constituted the making of a copy of it. If this decision stands, every reception of a television program may constitute the making of a "copy," requiring that the reception of the televised work be licensed. Licenses to televise must therefore include not only the right to transmit but also the right to receive and authorize others to receive broadcasts.

The decision holds another serious problem for television broadcasters, for, if television reception constitutes the "making of a copy," the broadcasters may be held to have made copies generally available to the public and thus to have made a general publication of the program, which would destroy any common-

law rights that he had in the material upon which the program was based. This situation requires detailed study.

As in the case of motion pictures and the performance of musical and literary works, it is essential for the broadcaster to secure licenses specifically authorizing the use for television of selected pages of copyrighted books, manuscripts, letters, documents, pages of music, or representations of pictures. In each case, the license must authorize copying, transmission, and reception.

The prevailing legal restrictions on slander and libel will of course apply to television programs. Although the few test cases that have been tried up to the present indicate that defamation by radio is slander rather than libel, it is possible that the law will consider defamation by television as libel which would remove the necessity for the party claiming injury to prove special damages flowing from the act. Also, it must yet be finally determined exactly what the broadcaster's liability is in case of defamation. These are more points for litigation.

In general, it is to be assumed that the same restrictions on use of names and portraits of individuals for purposes of trade will apply to television as to motion pictures and sound broadcasting. In many cases, it may be necessary to obtain written releases from those persons whose likenesses are televised. Many phases of the general problem of televising proper names and individual portraits remain clouded. In order to familiarize himself with the attitude of the courts and to protect his interests, the broadcaster may have to carry a number of specific situations into litigation.

NBC's contract with the New York local of the American Federation of Musicians provides that, so long as television remains experimental, we may employ musicians for television programs at prevailing radio rates. The union, however, has advised that they intend to demand increased compensation for musicians on television programs when and as they become commercial.

These considerations by no means constitute a complete analysis of the relations between the broadcaster and his performing artists. They do, however, indicate some of the questions that may be raised in the next few years. Future developments will undoubtedly dictate certain modifications of decisions and procedures.

A final group of problems having legal aspects, which will arise with the coming of commercial television, concerns the relations between the broadcaster and the advertising agency. If television follows the trend developed in sound broadcasting, it will also present substantially the same questions. Since we have little factual basis for a discussion of the agency problem, it is perhaps advisable to limit this section to a mere enumeration of anticipated questions. These include:

Indemnification by the broadcaster of agencies and advertisers with respect to programs built by the broadcaster, on the material he furnished, including the music cleared.

Indemnification by agencies of the broadcaster as to the program that they build or the material they furnish.

Broadcaster liability to agencies and advertisers for interruptions, delays, and unavailability of stations.

The appropriation of a commercial program's time on a network for events of national importance, or one station appropriating a program's time for any event of local importance.

Broadcaster's liability where the use of facilities is interfered with by labor controversies.

A rebate to the advertiser or agency for talent fees in case broadcasting facilities are recaptured for special events or news bulletins.

Finally, the problem of shaping a policy for extending the use of television facilities for political programs.

It is premature to discuss the procedures for handling the foregoing problems and far wiser to examine each problem as it arises in the onward march of the art.

It may seem from this brief discussion of some of the legal problems connected with television that the difficulties encountered in getting a program on the air are almost insurmountable. Far from it. Similar ones have been faced in connection with sound broadcasting and to a large extent have been solved. There is no reason to doubt that as television develops, these problems will be worked out without unduly handicapping its development. Although the broadcaster may go through a difficult period during which his rights and obligations are being defined, there can be no question that time and constant application to the problems will cure them.

CHAPTER XII

THE TECHNICAL ELEMENTS OF THE TELEVISION SYSTEM

In Chaps. II and III, we examined briefly some of the technical equipment and methods employed in television. In order to appreciate the capabilities and limitations of the system, a more detailed examination of the technical elements is essential. Consequently, in this chapter, we shall discuss the engineering techniques and equipment used in television, with special reference to their relationship to the system's performance capabilities.

The technical features of the television systems depend fundamentally on the nature of the "scanning process" adopted as the standard reference for transmission. By this is meant the dissection of each picture into lines at the transmitter and the reassembly of the picture at the receiver. The necessity for scanning arises from the fact that the information in each picture must be sent "piecemeal," because the communication circuit can handle but one item of information at a time. The speed with which the scanning process proceeds must be fast enough to deceive the eye, so that each image appears to be presented to the eye at one time, rather than as a succession of picture elements traced by a single point of light.

Each complete picture, composed of lines, must be presented to the eye in a very short time. When one such picture is completed, another picture is sent which, when completed, is succeeded by still another, and so on. The scanning process is thus a repetitive one, and its repetitive nature is what permits the representation of moving objects in the reproduced picture. If the objects in the picture are stationary, then each successive picture is the same; but if any motion occurs in the image, each successive picture differs slightly from the preceding and following ones. The differences are so small that they are not perceptible to the eye individually; but when they are presented to

the eye in rapid succession, they give the impression of smooth and continuous motion. This is the principle on which motion-picture technology is based. The only essential modification of the principle, as applied to television, is the fact that in television each successive picture is itself composed of a succession of "picture elements" which are laid down before the eye, one after the other, in a pattern of lines.

The dimensions of the scanning process can be decided, more or less arbitrarily, if only one transmitter and one receiver are to be considered. But in television broadcasting, many receivers may be tuned successively to any of several transmitters, and it is desirable, therefore, that standard dimensions and rates be set up for the scanning process. The essential questions to be decided in standardizing the scanning process are the number of lines in each picture, the rate of repeating the pictures, and the ratio of the picture width to its height. A great many subsidiary standards must also be decided upon, such as the manner of interlacing, the type of synchronizing signals to be employed in keeping the transmitter and receiver scanning patterns in step, the manner of transmitting the average brightness in the picture, and the sense or polarity of the image tones (*i.e.*, whether negative or positive, in the usual photographic sense) at the output of the transmitter.

In this country, the standards question has been studied by the Television Committee of the Radio Manufacturer's Association. The recommendations of this committee (which contains members from most of the television development laboratories in this country) have been used as the basis for television transmission by the National Broadcasting Company and by other American broadcasters. Briefly, the most important of these standards are as follows: Each picture contains 441 lines from the beginning of one picture to the beginning of the next. Roughly 400 of these lines are active in reproducing the received image. These "active" lines form a rectangle the width and height of which are in the ratio 4:3. The successive pictures are presented at a rate of 30 per second. Each picture is divided into two parts composed of roughly 200 "active" lines each presented successively at a rate of 60 per second and in such a way that the lines in each successive set are interlaced, *i.e.*, fall between the alternate lines previously traced.

To understand the reasons underlying the choice of these standards, we begin with the rate at which the pictures are repeated. If this rate is sufficiently high, the transmission of a single picture occurs rapidly enough so that the eye appears to see all the picture elements in the picture at once, rather than in succession. This requirement is met if each picture "frame" is presented in $\frac{1}{30}$ sec., which is well within the time of persistence of vision. In other words, the rate of presenting the suc-

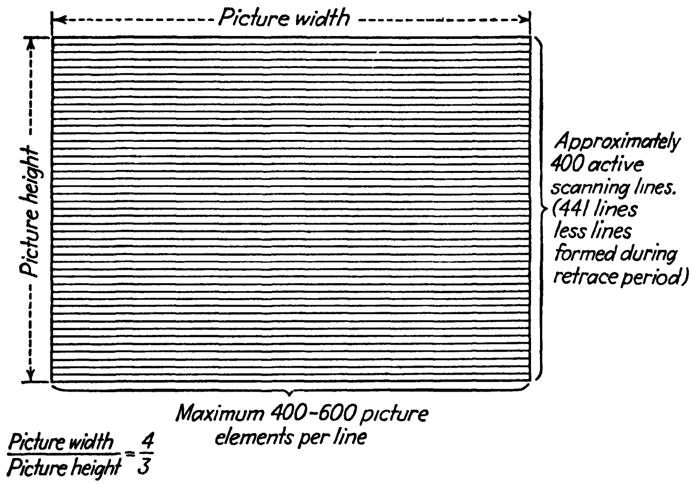


FIG. 61.—Some television standards associated with the physical dimensions of the picture.

cessive pictures to the eye must be fast enough to obscure the scanning process and to make it appear as though the whole receiving screen were continually illuminated. When this requirement is met, it follows that motion may be depicted in the transmission of the picture, since any motion in the image is divided into a succession of smaller motions, which by themselves are so small that the eye sees them not individually but as a continuous motion.

Thus the frame-repetition rate, standardized in this country at a rate of 30 per second, rests essentially on two factors: the duration of persistence of vision and the representation of motion in the image. The choice of 30 frames per second as the standard is not absolute; this might have been between 25 and 35 frames per second, since the persistence effect operates satisfactorily

within these limits. The number 30 per second was chosen because this number is one-half the frequency of the power-supply systems which, in most parts of this country, operate at 60 cycles per second. The one-to-two relationship between these rates makes it somewhat simpler, technically, to maintain the frame-repetition rate at a value of 30 per second. The power frequency is not in itself used to determine the frame rate, but the receiving and transmitting equipment would be somewhat more complicated (and hence more expensive) if the frame rate and the power-system rate were completely divorced. This does not mean, however, that the power supply at the receiver must be synchronized precisely with that at the transmitter. Several independent, nonsynchronous power systems feed various districts of the New York metropolitan area, but completely satisfactory reception is given by modern television receivers in all of these districts.

When pictures are presented to the eye at a rate of 30 per second, it is found, especially if the pictures are bright, that flicker is apparent. This flicker can be eliminated by raising the frame-repetition rate to, say, 60 per second. But this would force the whole system to operate at twice its normal rate of speed. The picture detail would then suffer by a factor of two, unless approximately twice the space in the ether were used by each television station. To avoid this complication, the frame-repetition rate is maintained at 30 per second, but 60 half pictures are presented to the eye in a second. Though only 30 complete pictures per second are thus presented to the eye, 60 light impressions are received by the eye in that time, and as a result the flicker is generally undetectable.

The technique of presenting each picture to the eye twice is known as "interlacing." It consists in sending the lines in the image in alternate fashion (*i.e.*, lines numbered 1, 3, 5, 7, etc., followed by the lines numbered 2, 4, 6, and 8). The two sets of lines are made to fall one set within the other, *i.e.*, one set occupying the blank spaces between the lines of the other set. Each set of lines is called a "field," two fields making a complete frame. The field-repetition rate is accordingly 60 per second, which is twice the rate of frame repetition. The ratio between these two rates, 2:1, is known technically as the "interlace ratio." The significance of these frame- and field-repetition rates may be

summarized simply: The interlacing ratio insures the absence of flicker, whereas the frame rate takes advantage of the persistence of vision and allows the depiction of smooth motion in the image.

The limitation imposed by frame-repetition rate is this: If the motion in the image is very rapid, the frame rate of 30 per second may be insufficient to make it appear smooth. This frame rate is faster than that of motion pictures in the theater which have a picture repetition rate of only 24 per second. This effect was noted in a recent NBC television broadcast in which a team of jugglers was engaged in throwing Indian clubs rapidly across the stage. The speed with which the clubs moved was such that they progressed several inches in the time between successive frames, and as a result the reproduced picture showed the clubs as proceeding in "jerks" of motion. This difficulty may be avoided by restricting rapid motion across the face of the camera. If rapid motion must be depicted, it should be made to occur *toward* the camera rather than *across* it. Another curious effect can be traced to the frame-repetition process. Among them is the stroboscopic effect which causes the spokes of wheels to appear to turn backward.

Interlacing produces a minor defect which is ordinarily apparent only if the motion across the screen is rapid and in a horizontal direction. In this case, the successive fields present the image at slightly different positions, and the vertical edges of objects moving horizontally appear to have a jagged "sawtooth" appearance. The remedy in this case is the restriction of rapid horizontal motion. The jagged edges are much less evident than the jerkiness of motion due to the result noted in the preceding paragraph. However, an interesting psycho-physiological factor which partially compensates this effect is that the eye is less critical of the lack of detail in a scene depicting motion.

The frame- and field-repetition rates, despite the difficulties just discussed, are, in the main, entirely satisfactory and do not restrict the program producer if he observes the rules ordinarily applied in motion-picture production.

Thus far, we have been concerned only with the repetition of successive pictures (fields and frames). Now we direct our attention to a far more serious question—that of the number of lines in each picture and the amount of pictorial detail that the lines can accommodate. The number of lines, from the beginning

of one frame to the beginning of the next, has been standardized in this country at the value 441. Of these 441 lines, approximately 400 are active in presenting the reproduced picture to the eye. The remainder of the lines are lost during the period of frame changes. Along each line are gradations of light and shade, composing the picture. The number of picture elements which may be reproduced in each line depends on the ability of the television transmitter and receiver to reproduce very rapidly varying values of electric current, and on the size (area) of the scanning beam spots in the Iconoscope and Kinescope. The maximum limit of which the present television system is capable is about 500 picture elements per line. Since the picture is composed of approximately 400 such lines, it follows that the total number of picture elements reproducible is about 200,000. If the receiver or transmitter is not working to its full specifications, the number of picture elements is proportionately reduced.

We may logically inquire how a television image containing 200,000 picture elements compares with other means of visual representation. To do so we must compare pictures similar in size. The largest television pictures produced for home receivers in this country to date are approximately 8 by 10½ in. A printed half-tone engraving of the same dimensions, of the 60-dot-per-inch variety commonly used in newspaper printing, contains about 400,000 picture elements (the picture element in this case is the individual half-tone dot of the picture structure). Finest half-tone engravings (133-dot-per-inch screen used on glossy paper) contain roughly 2,000,000 half-tone dots in a picture measuring 8 by 10½ in.

In motion-picture film, picture elements are determined mainly by individual silver grains making up the image structure. The number of such grains in a single frame of 35-mm. film depends upon the type of emulsion and the manner of processing. Fine-grain stock properly processed is capable of producing about 500,000 picture elements per frame. The smaller (16- and 8-mm.) films contain roughly one-quarter and one-eighth as many picture elements, respectively. The television system is thus capable of transmitting virtually all the information contained in a good-quality 8- or 16-mm. film but not all the information contained in a professional 35-mm. film.

The ultimate in pictorial representation, the fine-grain contact-printed photographic print, may contain as many as 10,000,000 picture elements in an 8- by 10½-in. area. Compared with such a picture, television is a very coarse medium indeed, but very few subjects require such fine detail, because the eye itself is not capable of assimilating it unless the picture is viewed under a magnifying glass and it would be lost when viewed from the optimum distance to a television screen, which is normally 6 ft.

This brief comparison of the television image with other forms of pictures reveals that the television system is adequate for most types of subjects. But it cannot, and should not, be used for subjects that must be reproduced in detail finer than the system can reproduce. The same limitation applies, in a somewhat lesser degree, to motion pictures. The television rule is to keep the camera as close to the subject as the action of the performance permits. Long shots, where necessary, should be of short duration.

We have seen that the detail-reproducing capability of the system is limited by the number of lines in the image and the number of picture elements that can be accommodated along each line and that the figures that apply in current television practice are 400 lines and 500 elements per line (the latter figure under ideal conditions). We may inquire why, for example, 1,000 lines and 1,250 elements per line were not chosen. Such a television system would, admittedly, be capable of reproducing pictures considerably superior in detail to the best motion pictures.

The reason for the present limitation is not hard to find. Consider television pictures containing 400 lines of 500 elements per line (which, it must be remembered, represents the system working at its best). Each picture contains 200,000 (400 × 500) picture elements. The pictures are reproduced at a rate of 30 per second. The picture elements must then be sent at a rate of 200,000 × 30 = 6,000,000 picture elements per second. In other words, the electrical system must convey impulses at a working rate of 6,000,000 per second. If one-half these impulses represent bright elements, and one-half dark (as they do on the average in most scenes), then there are 3,000,000 "bright" and 3,000,000 "dark" impulses. A single cycle of

electric alternating current can accommodate one dark pulse and one bright pulse; hence the frequency at which the system must operate is approximately 4,000,000 cycles per second, because of other impulses necessary for synchronizing and blanking.

Consider now the 1,000-line picture, each line containing 1,250 elements. There would be 1,000 × 1,250 = 1,250,000 elements per picture, transmitted at a rate of 30 pictures per second, or 1,250,000 × 30 = 37,500,000 impulses per second. The electrical current in this case would have to alternate 18,750,000 cycles per second. At present, there is no technical equipment capable of transmitting a picture signal whose fine detail corresponds to such a high rate of transmission. Even if a system were available (and it seems likely that in future years it will become feasible to produce it), the fact remains that the space required in the ether for a single television station transmitting such an image would be so extensive that there would be no room for such a station in the portions of the ether spectrum now available for television stations. New regions in the spectrum, above 300,000,000 cycles, on centimeter wave lengths, are now being explored, and here will be found abundant frequencies affording sufficient room for such stations.

With these considerations in mind, among others, RMA recommended a standard number of lines at the value of 441, of which about 400 are active in reproducing the picture. The exact value of 441 for the number of lines from the beginning of one frame to the beginning of the next was chosen because that number is composed of simple odd factors (7 × 7 × 3 × 3 = 441). This arrangement of odd numbers makes for simplicity in generating the synchronizing impulses that control the scanning process, as we shall see in later paragraphs.

Before leaving the matter of picture detail, it is desirable to investigate the relation between the picture detail present in the picture and the desirable distance at which the picture should be viewed. It is obvious that, if the picture is viewed at too short a distance, the elemental structure will be clearly discernible and may be an annoying distraction. On the other hand, if the picture is viewed from too far away, it occupies a small part of the total field of vision, and the eye may not be able to distinguish all the detail actually present. Somewhere between these two

extremes there is a "most desirable viewing distance" which represents the best compromise.

In determining the desirable viewing distance, it is necessary to return to the basic characteristic of the human eye known as "visual acuity." Visual acuity is a numerical measure of the ability of the eye to distinguish the details in the scene before it. This ability depends on the fact that the retina of the eye is composed of many light-sensitive elements, known as "rods" and "cones." The most sensitive region of the retina, the fovea, contains cones that are capable of perceiving light separately and individually.

Each of these cones is connected to a separate fiber of the optic nerve and hence is capable of producing an individual sensation in the mind of the observer. Suppose that the eye is focused on an image composed of picture elements. If the picture is close to the eye, the image focused on the retina is correspondingly large, and each picture element is proportionately large. Suppose, then, that each picture element, as focused on the cones in the retina, is large enough to cover a group of several cones. Then this group of cones transmits to the brain an individual sensation that describes this particular element. The picture elements are, in other words, perceived individually as such, and the picture structure is evident. Now, suppose that the distance between the picture and the eye is increased until the size of the picture elements, as they are focused on the retina, becomes smaller than the cones on which they are focused (*e.g.*, two picture elements focused on one cone). Then the eye no longer sees the elements separately, and the picture structure becomes indiscernible. The distance at which this occurs is the most desirable, or "optimum," viewing distance. If the picture is viewed closer than this, the structure is evident. If it is viewed farther away, part of the picture detail is lost.

This optimum viewing distance can be found by a very simple experiment. Suppose that a piece of white paper with two closely spaced small black dots on it is viewed at first closely and then at increasing distance until the two dots just lose their separate identity and appear to fuse into a single one. At this distance, the "picture structure" represented by the two dots just ceases to be discernible; and according to our definition, this is the optimum viewing distance for a picture made up of

such dots. It is evident that the optimum distance depends on the size and separation of the dots. If we measure the *angle* between the lines of sight from the eye to the two dots, we find that the value of this angle at the optimum viewing distance in eyes of average acuity is 1 min. of arc. The value of this angle is known as the "visual acuity of the eye." Now, 1 min. of arc represents the angle between two lines of sight to dots whose separation is roughly 1/3,500 of the viewing distance. In other words, if the dots are separated by ¼ in., they are separately visible until the viewing distance is 3,500 times as great, or 875 in. (73 ft.). For dots separated $\frac{1}{50}$ in. (typical in television work), the optimum viewing distance is 3,500/50 = 70 in., or roughly 6 ft.

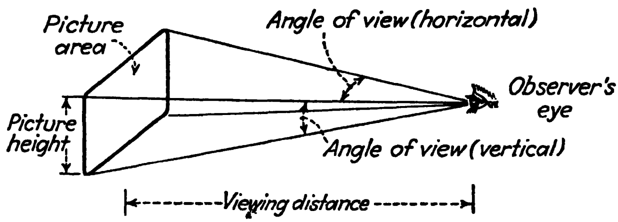


FIG. 62.—The factors considered in connection with viewing angles.

Experience shows that the image may be viewed closer than the optimum viewing distance provided that the action is fast. But when the picture is viewed closer than, say, half the optimum viewing distance, the picture structure may be objectionably evident. Viewing the picture closer than this provides no more detail for the eye and does make for distraction, because the separate elements of the image are clearly evident.

A convenient way of expressing the optimum viewing distance is in terms of the picture height. The picture contains 400 lines. Under ideal conditions therefore, it is capable of representing, in the vertical direction, 400 picture elements. The height of the picture contains these 400 elements; consequently, the separation between elements is $\frac{1}{400}$ of the picture height. The optimum viewing distance is 3,500 times this separation, or $3{,}500 \times \frac{1}{400} = 8.75$ times the picture height. This value is based on the visual acuity of 1 min. of arc. Experience with television pictures shows that a viewing distance shorter than four times the picture height is undesirable and that viewing

distances greater than eight times the picture height cause a definite loss in observed detail.

It is interesting to compare these viewing-distance–picture-height ratios with those which obtain in motion-picture theaters. The front seats of the theater are situated a distance from the screen equal to about twice the picture height. Those who view the picture from this point can very readily see the detailed picture-element structure (silver grains) in the picture. Furthermore, the picture covers so wide a field of view that it is necessary to move the eyes excessively to follow the action, and this may become very tiring. On the other hand, the seats at the rear of most theaters are situated a distance from the screen equal to as much as ten times the picture height. That the picture can be enjoyed from such seats cannot be doubted, but much detail is lost that patrons near the center of the house can readily perceive. Experience seems to show that the seats that fill up first are those at a 4:1 ratio of distance to picture height, confirming the experience already noted in connection with television images.

It might appear from this analysis that television pictures larger than 8 in. high are not necessary, provided that a viewing distance of from 3 to 6 ft. is considered comfortable in the average home. Distances of 5 to 10 ft. would be preferable for audiences larger than four or five people, and this indicates the desirability of a picture, say, 14 in. high. The larger picture has another effect which may be of considerable psychological significance, and that is that when a small picture is viewed closely, the eyes must view it in slightly "crossed" position, whereas a large picture viewed from a proportionately greater distance is viewed with the eyes pointing more directly forward. The effect of this factor on eye fatigue seems to be worthy of investigation.

Television is designed for use of the family in the home and not for an audience, which may be defined for purposes here as more than eight people. The average living room seldom permits a viewing distance of more than 12 ft.

In the preceding paragraphs, we have confined ourselves to the detail measured along a vertical line in the image, since this is the detail represented by the lines in the image; and we have found that in this dimension, no more details can be represented than there are lines. In the horizontal direction, on the other hand, the details are reproduced by variations in the brightness

of the line as it is traced across the screen. The number of details in the line thus depends on how many times the brightness of the scanning spot may be varied while it is moving across the line. We have seen that the limit at present corresponds to an alternating current of roughly 4,000,000 cycles per second and that, in many actual cases, the alternations actually reproduced vary no faster than 2,000,000 cycles per second or less. Considering the former figure as representative of best practice, and noting that each line is traced in roughly 1/14,000 sec., we find that there are $4{,}000{,}000 \times 1/14{,}000 = 287$ cycles for each line. Since each cycle can reproduce one white and one black picture element, we find that the maximum number of picture elements in the line is 575 per line. This figure exceeds the 400 picture elements in the vertical direction, but we remember that the ratio of the width to the height of the picture is 4:3. Consequently, the number of the elements along each line, to equal the spacing vertically, should be $400 \times 4/3 = 532$ elements. The actual figure computed above, 575 per line, indicates simply that the detail of the picture horizontally is somewhat greater than the resolution vertically.

Actually, the disparity between the two directions of resolution is greater than these figures indicate, because we have been assuming that, in the vertical direction, each line is capable of representing one picture element. Actually, the positions of the picture elements in the scene to be reproduced are not so fortunate as to lie on each line of the image. Often some picture elements fall midway between two lines, and it takes two lines to represent such elements. Experience shows that a pattern of 400 lines is seldom capable of showing more than 350 picture elements in the vertical direction. In this case, the detail resolution horizontally is considerably greater than it is vertically.

Having examined the implications of the scanning process, regarding the detail and dynamic quality of the image, we can proceed now to the equipment that makes use of the scanning pattern in generating the electrical counterpart of the picture. This electrical counterpart goes by the name of the "video signal." The video signal is a succession of electrical impulses, part of which represent the variations of light and shade along each line in the image, the remainder being specialized signals for maintaining synchronism between the scanning processes

at the transmitter and the receiver and for blanking out the return traces of the beam in the Kinescope. The first group of impulses, corresponding to the picture elements, is generated in the Iconoscope tube of the television camera. The second, the synchronizing and blanking pulses are produced in a synchronizing generator. The two sets of signals are combined in the video amplifiers employed to build up the voltage. The signal issuing from the final amplifier containing both sets of impulses is usually known as the "composite video signal," or simply "video signal."

If the video signal were applied to the control electrodes of a cathode-ray picture tube and to the scanning circuits that cause the spot in the tube to scan the screen, the picture would be directly reproduced. However, the signal must be sent over the air, between transmitter and receiver, and this process necessitates the introduction of several intermediate transformations. Essentially, the signal is imposed on an ultra-high-frequency radio wave, or "carrier," which is radiated into space from the antenna. At the receiver, this modulated wave is amplified, and then the video signal is separated ("demodulated") from the carrier signal. The video signal is thereby obtained in the form in which it left the final amplifier mentioned in the preceding paragraph. The composite video signal is then applied to the Kinescope and the scanning generators, and the picture is reproduced. Each of these processes is described more in detail in the following paragraphs, in the sequence actually followed by the signal in practice.

We begin with the television camera and its essential component, the Iconoscope. The camera itself is somewhat similar to any other type of camera; *i.e.*, it is a closed box containing, at one end, a lens the position of which may be changed for focusing the image on a light-sensitive plate. This light-sensitive plate, which is enclosed within the Iconoscope, is in many ways similar to the plate used in an ordinary camera, because its function is to store up a *latent image* of the scene focused upon it. In ordinary photography, the latent image is photochemical in nature, and it is developed by chemical means. In the Iconoscope, however, it is photoelectrical in nature and is developed by electrical means.

The image plate in the Iconoscope is a flat, uniformly thin piece of mica, measuring about 4 by 5 in. On the side of the

plate presented to the camera lens, several hundred thousand globules of silver are deposited, in the manufacture of the tube. It is important that each globule be separate and insulated electrically from its neighbors, since each is to receive an electric charge which it must store between the scanning of successive pictures.

In one particular process, to produce the globules, the mica plate is dusted with silver oxide powder through a fine mesh screen. Then the plate, with the powder covering it, is placed in an oven. The heat of the oven reduces the silver oxide to silver, and the oxygen is driven off. In the process, the silver draws up, or "congeals," into tiny half-spherical globules, in much the same way that powdered sugar acts when heated in an oven. Careful control of the heating process is necessary to produce an even distribution of globules sufficiently small in size and sufficiently separated to allow the mica plate to insulate them from each other.

When the silver globules have been formed, the plate is enclosed in the glass envelope, or "tube," and the air pumped out. First, the silver is oxidized. Then caesium vapor is admitted, and an electrical discharge is caused to pass through the tube. The result is that the silver droplets assume a coating of caesium and silver. This process renders the silver highly photosensitive. Finally, a thin coating of silver is deposited over the caesium coating. This process, known as "silver-sensitization," makes the response of the Iconoscope plate to colored light more nearly like that of the human eye than it otherwise would be and at the same time improves the sensitivity of the Iconoscope. The plate is then ready for operation.

Prior to inserting the mica plate with its silver globules in the Iconoscope tube, its back surface (side away from camera lens) is coated with a thin, uniform coating of colloidal graphite. The purpose of this coating is to form an electrical connection ("by capacitance" through the mica) with the silver globules on the other side. This back plate is connected to a terminal from which the picture impulses are passed to the external signal circuit.

In the long necklike projection of the Iconoscope is located a structure known as an "electron gun." It contains a surface of barium-strontium oxide which is heated electrically and which

gives off electrons. The electrons, once liberated, are caused to travel away from the gun by the presence of a positive charge which is applied to another electrode in the gun structure. The electrodes thus tend to stream through the gun, and in so doing they pass through apertures which confine the streaming electrons into a narrow beam. Further focusing of the beam is done electrically. The electron beam is roughly $\frac{1}{100}$ in. in diameter.

As the beam travels away from the gun, it is directed toward the mica image plate. In traveling to the plate, however, it passes through magnet coils which are mounted externally around the neck of the tube. Through these coils are passed currents which produce magnetic fields, and the magnetic fields, in turn, deflect the electron beam from its original line of flight. Two such sets of coils are provided. One (the horizontal deflecting system) is fed currents at a rate of 13,230 cycles per second, which cause the beam to scan the horizontal lines of the image (producing 441 lines for each of 30 pictures per second). The other set of coils (the vertical deflection system) is fed currents at a rate of 60 cycles per second, which cause the beam to move upward and downward. This vertical motion spreads the lines out into two fields which make a complete frame taking $\frac{1}{30}$ sec. By virtue of these deflection motions, the electron beam is forced to trace out a scanning pattern over the surface of the image plate, in accordance with the standards described earlier in this chapter.

We now consider what happens on the signal plate when light falls on it from the lens of the camera. Each of the globules tends to release electrons (negative charges) when it is illuminated. The number liberated depends on the strength of the illumination; that is, the more light the more electrons released. When the electrons are liberated, they are collected by a collector electrode within the tube, and each globule finds itself with a deficiency of negative charge, or, what is the same thing, with an excess of positive charge.

When a scene is focused on the image plate, the many millions of globules are illuminated with differing degrees of light intensity. Each globule gives off electrons in proportion to the amount of light that it receives. In this way, the optical image, in lights and shadows, is transformed into a latent image in electric charges. When electricity is distributed thus, it has a strong tendency to travel in such a way as to neutralize the

differences in charge. But the insulation (mica) between the globules prevents the charge from redistributing itself. In consequence, the latent image is trapped on the plate, and the charge-image is stored until use can be made of it. The ability of the Iconoscope to "store" light is among its most amazing properties. In fact, it is this property that provides the high sensitivity of the Iconoscope and makes it a practical electronic camera device.

We find, therefore, that the latent image stored in the form of electric charges on the image plate is available for electrical development. First, this electrical development must regain the stored charge and put it to use; second, the charge must be regained in the proper sequence for scanning. It is at this point that the electron beam, properly deflected in the standard scanning pattern, comes into play.

When the electron beam hits the globules on the image plate, it finds each with an electron deficiency. The beam is in a position to restore this deficiency. The actual restoration of the charge to the plate is a complicated process; it is not simply a filling in of electrons previously lost. But the net result is that the electron beam succeeds in restoring the charge deficiency (or, what is the same thing, removing the positive charge excess) on each of the globules as it passes them in the scanning pattern. The amount of charge restored at any point on the plate is in proportion to that lost which, in turn, is in proportion to the amount of light that falls on that point of the plate. The charge restoration is extremely rapid, since the beam is present, in passing over each droplet for only a fraction of a millionth of a second.

Now we turn our attention to the graphite coating on the back of the image plate. This coating forms an electrical condenser, with each silver globule on the opposite side of the mica. An electrical condenser has the property of developing a change in electrical voltage whenever the charge on its elements is changed. Now, the charge on each globule is caused to vary by the charge restoration; hence the voltage the condenser formed by this globule and the silver coating cause a change of voltage on the silver coating. Furthermore, as each droplet in succession receives its charge restoration, the signal-plate voltage continually varies, and, in so doing, the voltage on the signal plate

follows the charge restorations, globule by globule, as the scanning process progresses. In other words, the voltage changes are the same as the changes in light and shade along each line of the image, point by point.

In this way, the optical image is first transformed into a charge image, and then the charge image is scanned to produce an electrical signal which corresponds to the succession of picture

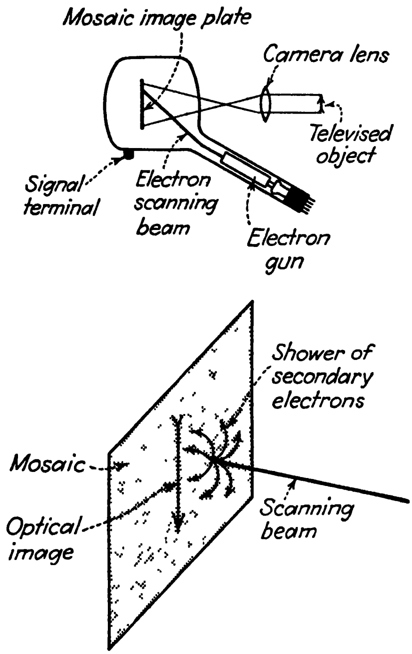


FIG. 63.—The essentials of the Iconoscope. Also, the existence of secondary electrons is shown diagrammatically.

elements in the image. The process then repeats itself, frame by frame, at a rate of 30 complete pictures (60 half frames, or fields, interlaced) per second. At each instant, the electrical voltage appearing at the signal plate and its associated terminal is a measure of intensity of the light on the picture element being scanned.

This process is a beautifully coordinated one and highly effective, but it is not without incidental difficulties. One of these arises from the fact that the electron beam, in scanning the image plate, causes so-called "secondary electrons" to be liberated

from the plate. These electrons are intimately associated with the production of the picture-signal impulses; but once liberated from the plate, they are no longer confined by the insulation of the mica. Rather, they may travel through the empty space in front of the image plate and then fall back to the plate some distance away. This constitutes an undesired redistribution of charge, which has no connection (except a very indirect one)

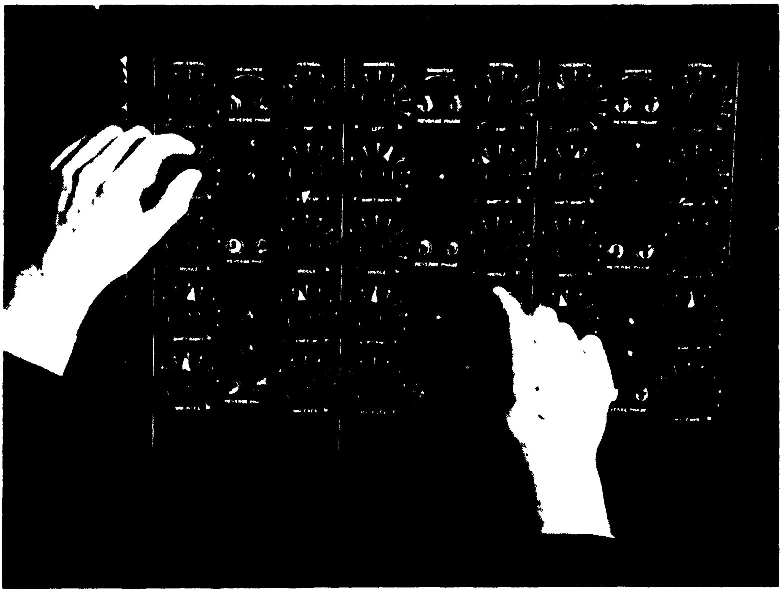


FIG. 64.—The shading panel in the control room.

with the optical image of the corresponding charge image. The redistribution of the secondary electrons causes an uneveness of shading in the reproduced picture which, unless compensated for, is a serious impairment of it. Fortunately, it is possible to insert, artificially, signals that compensate for the undesired electron distribution. The equipment for this purpose—the shading-correction generator—requires the attention of one operator through each performance. The operator has a series of knobs at his control with which he can correct shading imperfections as they appear. In a later form of picture pickup tube of the Iconoscope family, known as the Orthicon, these spurious shadings are not developed and the corresponding manual con-

trols and corrections are minimized or avoided. The Orthicon also has increased sensitivity.

Another difficulty, briefly mentioned, is the fact that the Iconoscope's response to color variations may be different from the response of the human eye to these variations. This may lead to striking, and often highly undesirable, effects. In general, the contrast of the transmitted television picture depends largely upon how the Iconoscope's response compares to the eye's. If a studio scene reflects but a single color, then the Iconoscope will respond faithfully to shades of that color. When, however, the studio scene reflects two or more colors, the contrasted shading of the television picture may look unnatural if the Iconoscope's spectral response differs from that of our eyes. This point may be illustrated by referring to experiences during NBC field tests.

The material used on the first Iconoscope plates was quite sensitive to the red and less sensitive to the yellow portions of the spectrum. The "response peak" in the red region of the visible spectrum made red objects appear unnaturally light in relation to other objects; consequently, lips appeared unusually light. Even with scarlet lipstick, the lip outline was barely discernible. This led to the practice of applying a brownish cosmetic which made the lips properly dark with respect to other parts of the face.

The first Iconoscopes falsified not only the reds and pinks of human complexion but also red signs, red fabrics, and red lamps. Under certain lighting, a sign of crimson lettering on a white background would fade into whiteness on the television screen.

Recent work in color-sensitizing the Iconoscope has resulted in an image plate that responds to all three primary colors and their various mixtures and shades, and hence it is no longer necessary to apply trick make-ups or invent freakish color schemes. The unflattering hues that depressed early television actors have been changed to shades that more closely resemble the natural complexion. With slight modification, today's standard television make-up is identical with that used in the movies.

Since incandescent lamps do not produce a true white light comparable to sunshine (they generate more red than blue or yellow), and since neither films nor Iconoscopes are equally sensitive to the primary colors, we compensate for these differences

by applying rouge, lipstick, and grease paint. As research work bestows upon the Iconoscope a more even color response, it may be necessary to make corresponding changes in the cosmetic tints used. Eventually, it may be possible to dispense with all but the most superficial make-up. As a matter of fact, many persons are televised at present without make-up.

That narrow portion of the wave-length scale that can be perceived by the eyes is called "visible light." Ultraviolet radiation lies above the visible frequency range; *i.e.*, it has a higher frequency, whereas infrared, which includes therapeutic heat, lies below the visible frequency range and is, therefore, of a lower frequency.

We encounter troublesome effects in the infrared region. To illustrate, many surfaces that appear dark to the human eye reflect infrared wave lengths quite well, and such surfaces may appear gray or even white on the television screen, if the pickup plate responds appreciably to them and if the studio illumination contains infrared.

With Iconoscopes having strong infrared responses, it is possible to "see in the dark" by television if a source of infrared radiation "illuminates" the subject televised. This may be called seeing in "black light," a phenomenon that may have practical application in industrial plants and in military operations. The spectral-energy distribution of the light illuminating a scene is equally important to the spectral response of the Iconoscope and to the afore-mentioned phenomena; therefore, in the selection of suitable light sources, their color content must be considered.

Outdoor pickups impose even more stringent requirements upon the spectral response characteristics of the Iconoscope than do studio operations. The chlorophyll in green leaves and grass strongly reflects infrared rays; hence, we are likely to witness a midsummer garden scene transformed into a midwinter snow scene if the Iconoscope has a strong infrared response. Therefore, tubes that are acceptable for studio operations may be totally unsuited for outdoor pickups.

All the deleterious effects resulting from infrared response in the Iconoscope would be repeated if the camera lenses and Iconoscope glass transmitted ultraviolet; but since ultraviolet light is filtered out by both the lens and the Iconoscope glass it does not affect video-signal transmission or reception.

The Iconoscope camera, like any other camera, must have sufficient light to work with, or the image produced will be "underexposed." When sufficient light is unavailable, the picture-signal impulses produced by the Iconoscope are correspondingly weak. It would be possible to amplify the signals electrically to make up the difference, were it not for the fact

A


Fig. 65.—*A*, a photo from a Kinescope on which the signal has proper shading and the subject has sufficient light; *B*, the same light but an example of poor shading. *C*, correct shading, but low light.

that in the camera are generated other interfering voltages, which arise from the random motions of electrons in the tubes and circuits. These random voltages are commonly referred to as "noise" in sound-transmission systems, and this term is widely used also in television work, though, of course, it cannot be heard. The strength of the noise voltages is fixed, independent of the camera action itself, by the tubes and circuit components used in the camera amplifier. Consequently, the presence of the noise voltages constitutes a level below which the picture-impulse signals cannot be allowed to fall. In fact, the picture

B

C

For descriptive legend see Fig. 65 on opposite page.

impulses must always be several times greater than the noise voltages, if a satisfactory picture is to be produced. The "signal-to-noise" ratio, must be kept within proper bounds or the noise becomes definitely visible as a vague blurring, or "graininess," in the picture. Amplification does not help this condition, since the amplifier acts equally on the noise and the desired signal. The remedy is to employ sufficient light which will strengthen the signal and thus tend to erase the extraneous picture noise.

Insufficient light has another indirect effect. It is possible to increase the strength of the signal relative to the noise by increasing the current of the electron scanning beam (increasing the number and velocity of the electrons in the beam). But if this is done, the beam is correspondingly more effective in releasing secondary electrons, and the uneven shading due to the redistribution of these secondary electrons is thereby accentuated. The remedy is to keep the beam current to a minimum, but this requires adequate lighting. Hence, to transmit a high-quality picture, it is usually desirable to use as much light as is conveniently possible, even though a recognizable picture could be transmitted with much less light.

The levels of studio illumination used in practice range from about 500 to 2,400 ft.-candles. Outdoor scenes have a much wider range of contrasts. Bright sunlight may produce a brightness of 10,000 ft.-candles; and when the sun is obscured by a passing cloud, the brightness may drop by a ratio of one hundred times. Adequate lighting for most purposes is usually taken at about 800 ft.-candles, and pictures can be sent if necessary (as in the case of sporting or news events at night) from lighting that supplies as little as 50 ft.-candles, but this would be extremely poor.

A problem intimately related to the amount of light required is the question of the width of the lens opening and its relation to the depth of focus. The amount of light received by the scanning plate varies as the square of the diameter of the lens opening. Consequently, if the available light is low in intensity, it is desirable to use a lens of wide aperture. The lenses commonly used on studio cameras have apertures as wide as $f/2.7$, although $f/4.5$ is the widest ordinarily used. The lenses are provided with an aperture stop that permits reducing the lens opening,

but ordinarily the cameras are operated with the lens at *f*/4.5, and the adjustment of the picture is obtained by changing the electrical amplification of the picture signal after it leaves the television camera.

The depth of focus (range of distance within which objects in front of the camera remain focused on the image plate) is severely restricted when lens openings wider than *f*/5 are used, and the restriction increases as the objects come closer to the camera. Thus with an *f*/3.5 lens, of 6 in. focal length, the depth of focus is roughly 2 ft. at a distance of 12 ft. from the camera. If the camera is focused on a close-up, however, say at an object only 4 ft. away, the depth of focus is reduced to about 6 in. Within this depth of focus, it is possible to accommodate the features of a performer's face, provided that the performer does not move outside the 6-in. range within which he will remain in focus. The camera operator, of course, is ready to change camera focus, should the performer move toward or away from the camera, but he cannot do it quickly enough to accommodate very rapid motions of the head or body away from or toward it. It must be remembered that depth of focus is not an absolute factor but is arbitrary for each scene.

The depth-of-focus problem is reduced as the lens opening is reduced, but this, in turn, requires more light to produce a given strength of picture signal. It appears that the most hopeful avenue of progress in this respect lies in research now under way to improve the sensitivity of the Iconoscope itself.

The signal generated by a television-camera tube, as already noted, is only part of the composite video signal. The remainder of the signal consists of so-called "blanking and synchronizing pulses." We discuss here the function of the pulses and the equipment used to generate them.

We remember, first, that the picture signals are generated only while the scanning beam is moving from left to right along each line in the scanning pattern. In the retrace motions, when the beam is traveling from right to left, the camera tube is inactive and this time is available for exercising control functions. Similarly, between frames is a short interval during which control functions can be accommodated. It is in these intervals between lines and frames that the blanking and synchronizing pulses are sent. The blanking part of the pulse simply serves to extinguish

the scanning spot so that the picture screen at the receiver remains in a dark condition during the retrace intervals.

The synchronizing pulses have a more specialized function. They must initiate the scanning motion at the beginning of each line and frame. The same synchronizing pulses are used to control the scanning motion at the camera tube and the receiver. (The tolerances allowable in connection with the camera tube are more rigid, but otherwise the pulses are the same, and they are derived from the same timing source.) Thus the scanning motions are constrained to occur in exact synchronism.

Perfect synchronization is required in the television system. If timing of a single line is delayed one microsecond (1/1,000,000 sec.) relative to the corresponding line at the transmitter, then all the picture elements in that line will be displaced to the left or right by a distance equal to about 2 per cent of the picture width. In an 8- by 10½-in. picture, this displacement corresponds to a distance of about ⅛ in. It is obvious that the position of the picture elements must be maintained much more accurately than this if a presentable picture is to be produced. Actually, the timing should be (and usually is) maintained to an accuracy of 0.1 microsecond or less.

These remarks apply to the timing of each line, but the timing of each interlaced field is no less exacting. The necessity for accurate timing of the fields and frames arises from the fact that the two interlaced fields must be made to fall accurately within each other, the lines of one field filling the blank spaces in the other. If the timing is not maintained accurately, the lines in one field will tend to "pair" with the lines of the succeeding field; and in the extreme case, the lines of one field will fall directly on the lines of the preceding and succeeding fields. In this case, only 200 lines in the reproduced picture will be visible, rather than 400, and the vertical detail in the picture suffers proportionately. The maintenance of accurate interlacing is thus a very important aspect of television engineering.

The timing generator of the entire system is located at the transmitting end of the system. The generator, known usually as the "synchronizing-impulse generator," serves as the time reference for the transmitter and for all receivers tuned to it. For the reasons already noted, the timing is tied in with the power-supply frequency of the local power system. In large urban

areas, fed by a single public-utility system, most of the receivers will be supplied from the same source, and the timing system is thus aided in maintaining synchronism. But the synchronizing impulses are designed to maintain synchronism regardless of the power-system conditions.

The timing generator has the task of establishing two fundamental rates: the rate of repetition for each field, 60 per second; and the rate of repetition for each line, which is 13,230 per second. The value 13,230 per second arises from the facts that 441 lines are included in each frame and that each frame (two fields) is formed in 1/30 sec.; hence the number of lines per second is $441 \times 30 = 13{,}230$.

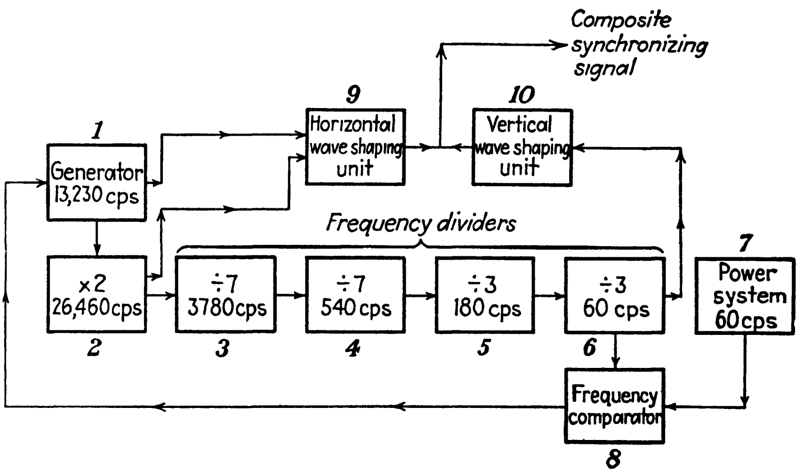


FIG. 66.—Diagram of generation of the composite synchronizing signal.

In the early attempts to devise a satisfactory timing generator, a mechanical-electrical device seemed to be the only suitable means. A large disk with holes cut in its periphery was rotated at high speed in such a way that the holes allowed light to pass, in pulses, from a lamp to a phototube situated on the opposite side of the disk. The pulsating photoelectric currents thereby generated in the phototube were amplified and used as the synchronizing pulses. But later developments in electronic circuits have made it possible to generate the pulses in vacuum-tube circuits without the use of moving parts. The timing generators used at NBC contain a total of some 80 vacuum tubes, and are operated

continuously 24 hr. a day, except when maintenance is necessary, in order to keep up the evenness of their timing characteristics.

The following brief outline of the manner of generating the required pulses (13,230 and 60 pulses per second) is based on the NBC generator: A vacuum-tube oscillator, which generates an alternating current of 26,460 cycles per second frequency, is used as the basic timing source. This frequency is twice as great as the required line-repetition rate of 13,230 cycles per second. The reason for using this double frequency is: (1) that a double timing rate is needed for the production of so-called equalizing pulses which are used in maintaining the field-repetition rate to the required accuracy; (2) that the number 26,460 is related to the number 60 by a whole number (441). Hence, by dividing the frequency 26,460 in a series of steps, the field-repetition rate may be obtained directly, from the same source as is used in timing the line repetition.

The frequency division from 26,460 to 60 cycles per second is accomplished in four steps. The four divisions are of seven, seven, three, and three times ($7 \times 7 \times 3 \times 3 = 441$). This is the reason, as noted previously, for choosing the number 441 as the basis of the scanning pattern; *i.e.*, because the number 441 is composed of simple factors. The frequency-dividing circuits are known technically as "multivibrators." Four of them are used in a frequency-dividing chain, with isolating amplifier circuits between each. There are other frequency-dividing circuits besides multivibrative which may be used.

The line-repetition rate is obtained by a single frequency division of two times, which reduces the 26,460 cycle per second basic rate to 13,230 cycles per second, as required. In this way, both timing rates are obtained, ultimately, from a single source.

An ingenious frequency-controlling circuit is used to tie in these repetition rates with the power system. The 60 cycle per second frequency which results from the four-fold frequency division is compared with the 60 cycle per second frequency of the power system by passing currents from these two sources through a rectifier circuit. From this circuit issues a direct current whose polarity (positive or negative) and strength depend on the frequency difference between the two 60-cycle sources. If both sources are exactly the same in frequency and in phase, the direct current is zero. However, if the power system gets

ahead of the timing generator, a positive direct current is generated. On the other hand, if the power system lags behind, the direct current is negative. The direct current is used to control the frequency of the basic 26,460-cycle generator. If the current is negative, it slows the oscillator down until the 60-cycle current derived from it falls in step with the power system. On the other hand, the current, when positive, speeds up the oscillator. In this way, the timing generator is continuously and automatically kept in exact synchronism with the power system. The reliability of this arrangement is such that the generator will operate for months without falling out of step by so much as a thousandth of a second at any time.

The timing rates thus derived from the oscillator must then be used to control another pulse generator which supplies the proper shape of pulses necessary to ensure accurate timing. This so-called "wave-shaping unit" is a component part of the synchronizing generator; it contains about 40 tubes, all of which are necessary to form the many parts of the blanking and synchronizing portion of the composite video signal.

The output of the wave-shaping unit is mixed with the output of the television camera in an amplifier circuit containing two tubes. The two tubes are fed separately, one from the camera, the other from the wave-shaping unit. Both tubes in turn feed a single circuit in which the two portions of the composite signal are mixed. The composite signal is thereby completely formed, and it remains only to transmit it, without impairing its quality, to all the receivers tuned to the station.

Before the video signal can be entrusted to the air, however, it is necessary to make sure that it represents a high-quality picture, of suitable contrast, brightness, definition, and composition. The only way of making sure that it is satisfactory is to apply it to a picture tube (Kinescope) and view the result. This process is called "monitoring the image." A special booth is provided, adjacent to the studio, with windows looking over the scene of action. The picture tube is placed so that the control operators can by merely raising or lowering their eyes view the scene in the studio and the televised reproduction. This direct comparison of the original and reproduced scenes constitutes a very severe test of the performance of the system up to that point.

The transmitter that puts the program on the air may be located a considerable distance from the studio. In the NBC installation, the studios are in Radio City, about a mile north of the transmitter at the Empire State Building. Between the two, it is necessary to provide a connecting link. Two forms of link have been used with equal success. One is the radio relay, consisting of a low-power high-frequency (156-Mc.) transmitter which relays the video signal, by a directive-antenna system, to a receiver in the Empire State Building. The other is a coaxial

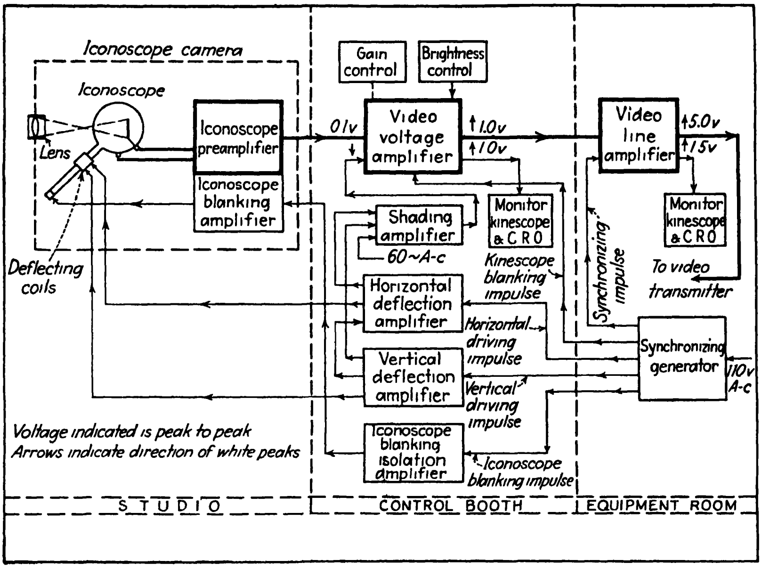


FIG. 67.—A typical one-channel television system.

cable, installed in conduits along Fifth Avenue and leased to NBC by The New York Telephone Company.

In transmitting the signal from studio to transmitter, amplification is necessary. This is accomplished by "line amplifiers," vacuum-tube repeaters which are capable of reproducing the entire range of frequencies (30 to 4,000,000 cycles per second) contained in the video signal. The output of the line amplifier, before it enters the coaxial cable, is viewed on a second monitor tube to be sure that no distortion has been introduced in the amplification process. When the signal reaches the transmitter, it is again viewed on a monitor picture tube. Then, if all remains

well, the signal is fed to the transmitter proper and finally radiated from the antenna on top of the building.

Throughout its trip from studio to receiver, it is essential to inspect the television image for quality. Certain types of subject are much better suited to such quality-inspection purposes than others. For example, a scene in rapid motion, especially if it is not familiar to the observer, is practically useless as a test of system performance. The observer looking at such a scene may derive satisfaction from the image, or he may find that "something is wrong," but it will be difficult to find the exact cause of the defect.

For this reason, a standard test chart has been adopted by television broadcasters for testing purposes. The chart serves the purpose of not only checking transmitter performance from studio to antenna but also allowing the television audience to determine the degree of performance of their individual receivers. Besides having the advantage of immobility, it is specially designed to reveal geometrical defects, to determine quantitatively the horizontal and vertical degrees of picture resolution and the range of shading gradations provided in the reproduced image. The standard test chart of the NBC-RCA installation is shown in the accompanying figure.

The chart used by NBC consists, first, of two large circles. The outer one has a diameter equal to four-thirds the diameter of the inner circle. The outer one just touches the left- and right-hand edges of the picture, and the inner circle touches the top and bottom. Under this circumstance, the width of the picture must be four-thirds as great as the height; *i.e.*, the picture has the standard "aspect ratio" of 4:3. If the reproduced picture is too narrow (aspect ratio less than 4:3), the circles will have an elliptical shape, with the major axis of the ellipses in the vertical direction. On the other hand, if it is not high enough, the circles will again appear elliptical, but the major axis will lie in the horizontal direction. The picture can be too narrow from either of two causes: The transmitter horizontal scanning is too wide, or the receiver scanning is too narrow. Similarly for the vertical scanning: If the picture is not high enough, the transmitter vertical scanning may be too great, or the receiver scanning too little.

The large circles in the chart have another important use. We remember that the scanning of the beams at transmitter and receiver must proceed at a perfectly uniform rate, or else the image will be too spread out at one edge or the other (left or right, top or bottom). Uniformity of scanning is readily checked by observing the shape of the circles. If the circles are egg-shaped, the evidence is that the scanning rate is not uniform. Thus, if the scanning rate at the receiver is slower at the left edge of the

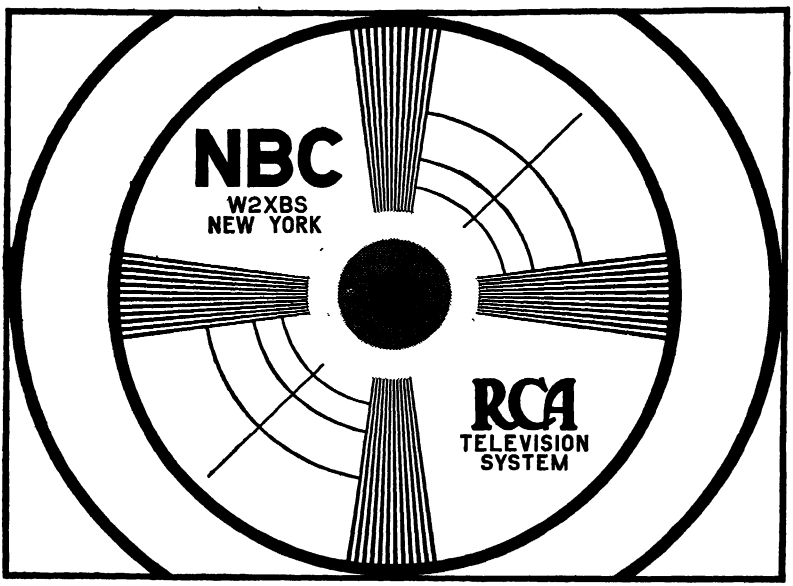


FIG. 68a.—The NBC-RCA standard test chart.

picture than at the right, the egg shape will have its long dimension horizontally, and the wide portion of the "egg" will occur at the left edge of the picture. An exactly similar appearance is caused if the scanning at the transmitter is faster at the left edge than at the right. Also, nonuniform scanning in the vertical direction is revealed by an egg shape having its symmetrical axis in a vertical line. Controls are available at the transmitter for correcting such defects, and most receivers have controls, at the rear of the cabinet, for adjusting this aspect of the scanning-generator performace. Ordinarily, these controls need no adjust-

ment during the life of the receiver but must be properly set when the receiver is installed.

We now turn to the interior structure of the pattern. Consider first the innermost, shaded circles, consisting of three concentric circular areas of differing density, the central area being black; the next (reading outward), of an intermediate gray tone; and the outer one, substantially white. These areas are used to set the contrast control of the system either at the transmitter or

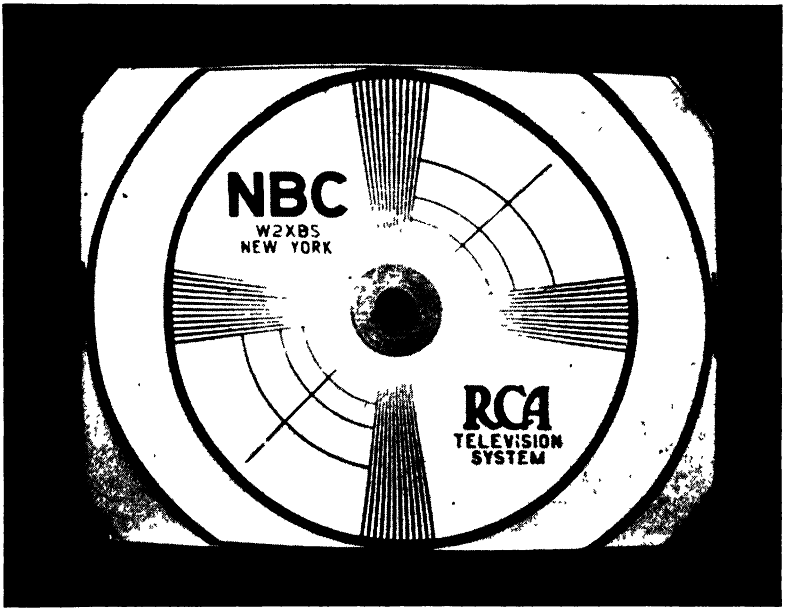


FIG. 68*b*.—The standard test pattern as reproduced by television.

at the receiver, depending on which is at fault. If the contrast control is set too high, the two inner areas will both appear black (*i.e.*, one degree of shading is "wiped out"). On the other hand, if the contrast control is too low, the whole picture may appear flat and of a uniform white tone. The optimum setting is an intermediate setting of the contrast control which gives a smooth graduation in all three sections.

Perhaps the most important aspect of pattern testing, so far as producing an enjoyable picture is concerned, is that associated with the "definition wedges" which extend in four directions

from the central shaded areas. These consist of vertical and horizontal black and white lines, arranged to have increasing width as they proceed from the center.

The wedges composed of horizontal lines are used to measure the vertical resolution of the reproduced image. At the outermost limit of the wedge, the width of one black line corresponds to $\frac{1}{150}$ of the picture height. This is called a resolution of "150 lines." Nearer the center, the resolution increases gradually to a maximum of 350 lines (width of black line equal to $\frac{1}{350}$ of the picture height). The calibration of the wedge is indicated by the quarter-circle markers in the lower left and upper right quadrants. The intersection of these lines with the wedges indicates resolutions of 200, 250, and 300 lines, reading inward.

The vertical resolution indicated by these wedges is produced by the low-frequency components of the signal. Since these components are ordinarily transmitted and received with ease, it is usual to find resolution of 200 to 350 lines under all conditions of reception. However, if the interlacing action of the successive fields is faulty, particularly if the fields are more or less paired, the vertical resolution is faulty. Adjustment of the synchronizing controls to obtain proper interlacing will result in a much improved appearance of the wedge. The vertical wedges are useful in judging the electrical focus of the system. If the scanning spot is not small in cross section, the fine detail in the inner portions of the wedges cannot be reproduced. Usually a setting of the focus control can be found that gives a maximum vertical resolution. As noted later, this setting of the focus control should also give a maximum of horizontal resolution as indicated by the wedges composed of vertical lines. If the same focus-control setting does not produce maximum resolution vertically and horizontally, the scanning spot has an elliptical shape. This is a fairly common defect in picture tubes. A compromise position of the focus control must be found in this event.

The discussion above of the effect of the number of scanning lines on the vertical resolution indicates that no more than 400-line resolution can be expected from 400 active lines and that in practice little more than 350-line resolution can be reproduced unless the lines of the scanning pattern happen to coincide exactly with the lines of the wedge. In picture tubes of small diameter (5 in. and smaller), the size of the scanning spot is so

large, relative to the picture area, that vertical resolution greater than 250 lines is usually not obtainable.

The horizontal resolution of the pattern is indicated by the wedges composed of vertical lines. Since the detail of these wedges is reproduced as the scanning spot sweeps across the lines, the reproduction occurs at very high speed, *i.e.*, by virtue of the high-frequency components of the signal. Since the high-frequency components of the signal are the most easily lost in the transmitting process, it is a common experience to find the horizontal resolution considerably poorer than the vertical. For example, horizontal definition of 250 lines can be reproduced only if signal components up to a frequency of approximately 2,500,000 cycles per second are reproduced. Only the best receiver can reproduce the maximum horizontal definition of 350 lines, since this requires a maximum signal frequency of nearly 4,000,000 cycles per second.

The horizontal-resolution wedges under discussion are also useful in checking the electrical focus of the system, in the manner noted in the case of the vertical-resolution wedges. The horizontal definition also indicates very precisely the accuracy of the synchronization of the various lines. A jagged appearance of the edges of the black lines indicates improper timing of the line synchronization. This defect may result from the fact that the picture-signal component of the video signal is "crossing over" to the synchronizing circuits (instead of being completely separated, as is required for good performance). This latter defect is more clearly indicated by an image in motion and is apt to appear in those portions of the image which have a heavy black tone at the extreme right-hand edge of the picture.

The position of the pattern as a whole indicates whether or not the vertical and horizontal centering controls are properly adjusted.

When the composite video signal reaches the transmitter proper, it must be superimposed on a carrier wave, by which it is radiated into space from the antenna structure. The generator of the carrier wave involves the so-called "radio-frequency" portions of the transmitter which are described in the following paragraphs.

The carrier wave itself, in the case of the NBC transmitter in New York, vibrates at a frequency of 45.25 Mc. per second,

but this frequency is not generated directly. Rather, a submultiple frequency (5.65625 Mc. per second) is used as the basis of the carrier wave. This frequency is generated in a quartz-crystal resonator, similar to those used in sound-broadcasting transmitters. The quartz crystal is maintained at constant tem perature, which insures that the frequency of the carrier wa\ shall remain constant. The frequency generated by the quart crystal circuit is then passed through four frequency-mul plying amplifier stages, each of which multiplies the frequen by 2. Thus, a total multiplication of eight times is performe. The final carrier frequency (5.65625 × 8 = 45.25 Mc. per second) is the value of the channel assigned to NBC by the Federal Com-

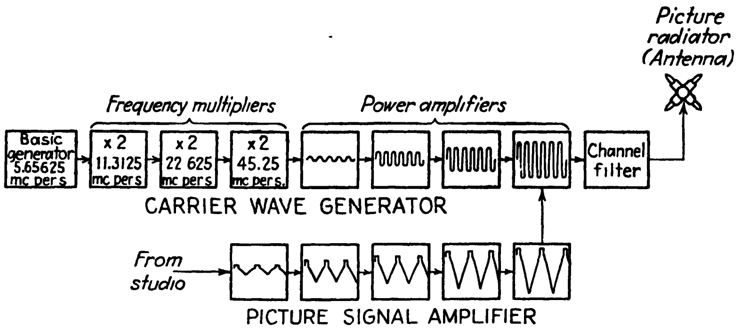


FIG. 69.—Diagram of frequency generation at the transmitter.

munications Commission. A similar arrangement is used to obtain a carrier wave of 49.75 Mc. per second, which is used to carry the sound signal associated with the picture.

The composite video signal is superimposed on the carrier wave in the last amplifier stage of the transmitter. Since this stage has a high power output, it is necessary that the video signal, when received from the coaxial cable, be amplified approximately one thousand times before it is strong enough to assume control of the carrier wave. This amplification is accomplished in a chain of video-amplifier stages, the last two of which employ large water-cooled tubes.

When the amplified video signal is imposed on the carrier wave, the strength (technically the "amplitude") of the carrier wave is caused to vary in accordance with the variations of the composite video signal. This process is known as "modulating" the carrier wave. In this manner, the intelligence contained in the

picture impulses and the synchronizing pulses is put in a form suitable for transmission through space. Later, in the receiver, the modulated carrier wave must be "demodulated" to remove the video signal, which is then used to control the picture tube and the scanning circuits.

When a carrier wave is so modulated, the carrier signal is considerably modified. One of the most important results is the fact that the carrier wave is no longer a single frequency (45.25 Mc.), as it is when not modulated. Rather, it is composed of a great many frequencies which surround the carrier frequency. The width of the band thus occupied depends on the frequencies in the video signal. If the top frequency in the video signal is 4,000,000 cycles per second, the band occupied, unless special precautions are taken, will be 8,000,000 cycles (8 Mc.) per second wide. This is an enormous "pathway" in the ether. Within this space, about 800 clear-channel broadcast stations could operate simultaneously. Since space in the ether is at a premium, it is necessary to restrict the band width occupied by the television station to a region as narrow as possible.

One method of reducing the space required, now in universal use in this country, is known as "vestigial side-band transmission." To understand the meaning of this term, we must note first that the band of frequencies is symmetrically disposed about the carrier frequency; *i.e.*, ordinarily there are two "side bands" which contain the intelligence of the picture and synchronizing pulses. These two side bands are identical; *i.e.*, both contain exactly the same information. If one of them could be eliminated, the reproduced picture need not suffer, and the ether space occupied by the television station would be reduced to one-half its original value. Unfortunately, the removal of one of the side bands is not simple, technically. So a compromise has been reached, whereby roughly 80 per cent of one side band is removed, and the remaining 20 per cent is transmitted. At the receiver, when the carrier wave is amplified, the active side band is partially removed, and the remnants of the other side band are added to the signal to make up the difference. Thus a symmetrical signal is developed in the receiver, and a picture free from distortion can be reproduced. The total space occupied in the ether by a television station under these circumstances is about 5.5 Mc. per second wide. When the sound carrier and its side bands are added to

the channel, and when provision is made for "guard bands" to separate the sound from the picture signals and to separate these signals from the signals of other television stations, the total band width occupied by the signals from a single television station becomes 6 Mc. per second wide. This is the standard channel width allocated to television stations by the FCC.

One of the difficulties encountered in radiating such a tremendous range of frequencies into space is the fact that ordinary antenna structures tend to radiate certain frequencies more readily than others. If the wide range of frequencies is applied to such a discriminating antenna, loss of detail results in the reproduced picture. This question has occupied the attention of radio engineers for some time. One of the outstanding solutions to the problem is the "Indian-club" antenna devised by

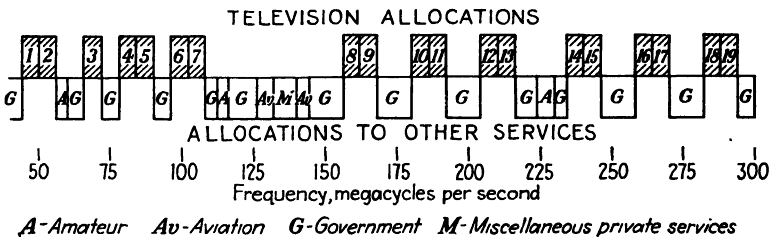


FIG. 70.—The television channels as allocated by the Federal Communications Commission prior to May 28, 1940. See Appendix II for changes made on that date.

the RCA Communications Company for the NBC transmitter. This structure, mounted on top of the Empire State Building, displays no discrimination within the television channel occupied by the station. The antenna can handle a band width that is roughly five times that which the present requirements dictate.

The region of the ether spectrum at present open for television stations extends from a frequency of 50 to 108 Mc. per second. Frequencies higher than this are also available for television channels and have been so allocated by the FCC. These have been used for radio-relay work. However, at present, channels on frequencies higher than 108 Mc. are not considered useful as a broadcasting channel direct to the television audience. It is difficult to generate high power on these high frequencies, using equipment now available; the sensitivity of receiver circuits is likewise low in this region of the spectrum.

At present, there are seven television channels, each 6 Mc. wide, that can serve as a basis for public television service: those between 50 to 56, 60 to 66, 66 to 72, 78 to 84, 84 to 90, 96 to 102, and 102 to 108 Mc. Many of the first receivers to appear were not equipped to receive all the channels, since it is extremely unlikely that any one receiver would be called upon to receive programs from seven stations in one locality. The number of channels provided range from two in the least expensive to five in the most expensive sets.

The reasons for choosing frequencies in the ultrahigh-frequency region between 40 and 100 Mc. are both economic and technical. Since each station requires a band 6 Mc. wide, the primary question was that of finding a region in the ether spectrum with room for several stations. The frequencies lower than 40 Mc. are completely occupied by services that cannot be displaced. These services depend on certain characteristics of the lower frequencies, which bring about desired results, such as to obtain long-distance transmission. The region of frequency higher than 40 Mc. (corresponding to wave lengths shorter than 7.5 m.) is not so thoroughly occupied, and there is sufficient room so that other services can be accommodated in regions of the spectrum between the television channels (56 to 60, 72 to 78, and 90 to 96 Mc.).

The use of frequencies above 40 Mc. has two other important advantages. Both should be amplified by a sentence or two. One is the fact that this region of the spectrum is freer from natural disturbances and from fading within the service range of the station (within the horizon distance). Another advantage, from one point of view, is the fact that these waves are not reflected from the upper atmosphere, as are waves of lower frequency, except under extraordinary atmospheric conditions. Such reflections would permit long-distance television transmissions, but they would also introduce "ghost images" due to the arrival of two or more signals at the receiving antenna with a slight delay between each two. Even if long-distance transmission were possible, it is probable that such reflections would produce very poor images, and such has been the experience of the engineers at the RCA Communications Laboratories at Riverhead, N. Y., where images have been received at rare intervals from the London transmitter. Since reflections are so serious, it is of distinct advantage to employ waves that are not

reflected. The loss of long-distance transmission (even if it were acceptable in quality) is counterbalanced by the fact that the same frequencies may be used simultaneously by several stations, provided that their geographical separation is sufficient to prevent interference.

A serious disadvantage of the frequencies higher than 40 Mc. is the fact that there happens to be considerable man-made interference in this portion of the spectrum. The most notorious offenders are the ignition systems of automobiles, particularly those of trucks and busses, and diathermy apparatus used by doctors. Both these sources are especially troublesome on the ultrahigh frequencies (above 40 Mc.) used in television. Fortunately, the cause in each case is remediable; and since it is man-made, it is quite possible to overcome it by cooperative effort. In the meantime, it can be fairly said that the most serious technical problem faced by the present television system is man-made interference. Cooperation between the professional engineering bodies and the engineering staffs of public utilities and public officials has already shown that much can be accomplished by cooperative effort.

Mention has already been made of the fact that carrier waves used in television are not usually reflected by the upper atmosphere. Reflection occurs on waves of lower frequency, and this effect accounts for the fact that such waves seem to follow the curvature of the earth. The absence of wave reflection in the case of television limits the reliable service range of a television station in many instances to the area that lies between the transmitting antenna and the horizon as viewed from the antenna. The waves can be made to cover substantially all this area; but at the horizon, the waves glance off the surface of the earth and travel on in outer space, where they are lost. The horizon distance (distance from antenna to horizon viewed from the antenna) is thus a very important quantity in determining the service capabilities of a television station.

A very simple relationship can be found between the height of the transmitting antenna and the distance to horizon as viewed from that height. A right triangle is formed by three lines: (1) the radius of the earth, extended to include the antenna; (2) the tangent from the top of the antenna to the earth's

surface; and (3) the radius of the earth drawn to the point of tangency. When this right triangle is solved, it is found that the distance to the horizon, in miles, is 1.22 times the square root of the antenna height in feet. Thus, it is simple to compute the horizon distance (which to a first approximation is

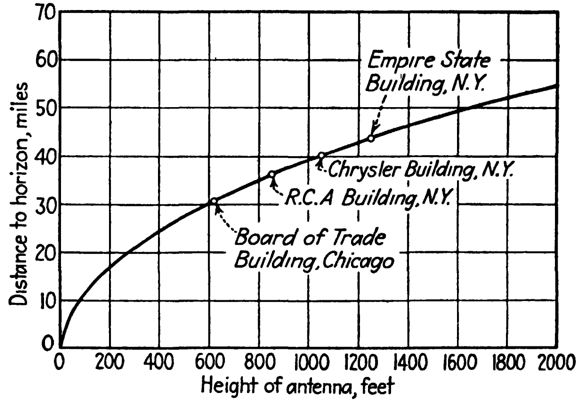


FIG. 71.—Horizon distances for given antenna heights.

the service radius of the station) in terms of the height of the antenna. This has been done in the following table:

Antenna Height, Feet	Service Radius, Miles
100	12 3
250	19.5
500	27.6
750	33.7
1,000	38.9
1,250	43.5
1,500	47.6
1,750	51.5
2,000	55.0

The highest man-made structure, the Empire State Building, is about 1,250 ft. tall, and the corresponding range is between 40 and 45 miles. Heights greater than this may be obtained from the tops of mountains. Thus, Mt. Washington, whose altitude above sea level is roughly 6,000 ft., has a horizon distance to sea level of 90 miles. But it is extremely unlikely that the territory within 90 miles of Mt: Washington will have sufficient population density to support a television service. Most small

cities can depend upon an antenna structure not higher than 500 ft., with a corresponding service radius of roughly 25 to 30 miles.

These figures must not be taken too literally, since they apply to level ground and take no account of obstructions such as hills, cliffs, and buildings which may reduce the horizon distance considerably. Furthermore, the analysis fails to take account of the fact that the waves do bend slightly around the earth, owing not to effects of reflection from the upper atmosphere but to the laws of optical refraction and diffraction which apply to all wave phenomena. Thus, it is not uncommon to receive satisfactory signals as far as twice the computed service radius, provided that the transmitter is of high power and the receiving antenna is favorably located with respect to the ground and to sources of man-made noise. The service radius based on the horizon distance is, nevertheless, a fairly reliable guide and can be taken as the first approximation in any case.

When the modulated carrier signal has reached the receiver location, it is necessary to provide a receiving antenna to intercept the wave and to deliver the signal to the receiver proper. For ordinary sound broadcasting, almost any type of antenna, from a short length of wire to an elaborate noise-reducing dipole, will suffice. But in television, a specialized antenna is imperative. An antenna designed for the short wave length involved is necessary, in the first place, to obtain maximum efficiency in transferring the energy from the carrier wave to the receiver. In the second place, it is necessary that the point at which the energy is picked up from the wave (the location of the antenna structure) be sharply localized to avoid introducing reflected signals that would produce double images or ghosts. The latter problem makes it essential that no signal be picked up in the lead-in wire from the antenna wire to the receiver. For this reason, the lead-in wire is almost always of the two-wire type known as "twisted pair" (or in elaborate installations a coaxial cable may be used for the lead-in).

The shape of the antenna itself depends on the conditions to be met at the receiving locality. If the signal is fairly strong, and if there are no reflected signals from near-by buildings, a simple pair of metal rods, each about 5 ft. long and arranged on a horizontal line, will suffice. The length of the rods should ordinarily

be arranged at right angles to the direction toward the transmitting station, since this assures maximum signal pickup. This simple two-rod antenna (technically a "half-wave dipole") has some directional properties and accordingly cannot be properly placed for all stations within range. A compromise position may usually be found which receives satisfactory signals from either of two stations.

If there are tall buildings or other signal-reflecting objects between the transmitter and receiver, and especially if they are in the near vicinity of the receiver, it may be necessary to employ more elaborate directional antenna to discriminate between the directly received signal and the reflected signals. Such difficulties as this make it highly desirable to have a trained technician install a television receiver.

It is not possible here to go into a detailed description of the functioning of the receiver, but a few items are of interest, since they have an important bearing on the satisfaction to be derived from the reproduced image. The signal delivered from the antenna lead-in is amplified and converted in frequency from the carrier value to an intermediate value of frequency, at which further amplification can be carried out with maximum efficiency and fidelity. The total amount of amplification in these portions of the receivers (r.f. converter and i.f. amplifiers) is usually of the order of five thousand times. Thus, a signal of 0.0005 volt, received from the antenna, becomes a signal of 2.5 volts at the end of the last i.f. amplifier. The signal, throughout this amplification process, is in the form of a modulated carrier wave. The modulated carrier is then applied to a demodulator tube which restores the composite video signal to the form in which it left the monitor at the studio.

The video signal is then used in two ways. The picture portions of the signal are amplified and then used to control the brightness of the spot in the picture tube and thereby to reproduce the half-tone variations along each line in the image. The blanking portions extinguish the spot during the retrace motions at the end of each line and field.

The synchronizing signals are separated from the composite video signal and are then amplified. Next, the synchronizing pulses intended to control the start of each scanning line are removed from those intended to control the start of each field.

Finally, each set of signals, separately, is used to control the timing of the respective scanning-current generators. These generators cause the scanning spot to move across the luminescent screen of the picture tube in exact synchronism with the corresponding scanning motions at the transmitter. The picture is thereby reproduced.

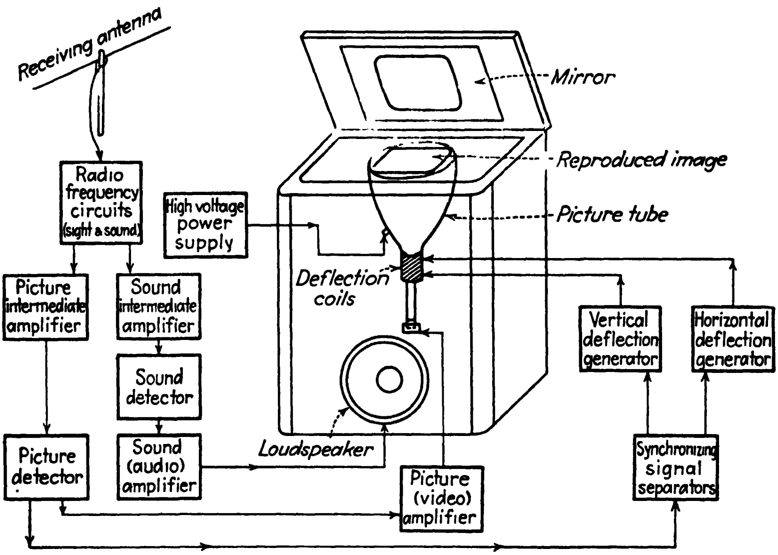


FIG. 72.—Diagram of the principal parts of a television receiver.

This description of the technical elements of the television system has been restricted to the picture-transmitting system. The sound associated with the program is picked up in a conventional microphone; amplified; sent over telephone lines to the transmitter; and there, after further amplification, used to modulate the carrier wave of a separate transmitter, the sole function of which is to transmit the sound part of the program. At the receiver, the sound carrier and the picture carrier are separated in the converter tube, and the sound is thereafter amplified separately, demodulated, amplified further, and applied to the loud-speaker.

CHAPTER XIII

SUMMARY OF REGULAR SERVICE OPERATIONS

During the period since Apr. 30, 1939, when regularly scheduled public programs commenced, the National Broadcasting Company has broadcast more than 700 separate television programs, constituting over 400 hr. of program time. The monthly spread up to 1940 is shown in the table following:

NUMBER OF PROGRAM HOURS BROADCAST SINCE APR. 30, 1939

Month	Total Hours
May	20.48
June	33.80
July	40.41
August	57.24
September	47.34
October	47.03
November	56.84
December	58.73

The extra hours in August were made up chiefly of the broadcast of the Eastern Grass Court Tennis Championship matches, from Rye, N. Y. The total hours for the 8 months represent an average of about 10 hr. each week. This average is increasing, since the programs are running between 10 and 12 hr. per week,

PERCENTAGE OF TOTAL TIME

	Outside	Film	Studio
May	46.2	14.3	39.5
June	40.2	16.0	43.8
July	1.1	51.2	47.7
August	32.3	45.3	22.4
September	21.0	35.1	43.9
October	35.0	22.1	42.9
November	32.0	36.1	31.9
December	31.2	35.2	33.6
Average	29.9	31.9	38.2

on a schedule of a little more than 2 hr. a day, 5 days a week, Wednesday through Sunday.

The programs consist of motion-picture film, studio productions, and outside pickups from the telemobile units. An analysis of the amount of time each of these program sources was used reveals that outside pickups and film broadcasts each consumed approximately 30 per cent of the time on the air; and studio productions, approximately 40 per cent. The monthly percentages for 1939 are shown in the table at the bottom of page 217.

Up to the present time, the television program watchword has been "Try everything." The table that follows indicates the extent to which this theme was carried out:

MONTHLY BREAKDOWN OF PROGRAM MATERIAL

Major program type	Percentage of total								Monthly average
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Children's	....	.....	...	0.4	....	0.5	0.4	1.5	0.7
Dancing	4.0	0.9	0.8		. .	..	.. ..	0.4	1.5
Drama	16.5	13.0	43.6	35.3	34.9	27.4	34.1	31.9	29.1
Educational	7.3	21.6	19.7	16.2	19.5	20.9	15.6	15.2	17.0
Miscellaneous	1.8	4.5	12.6	1.2	0.6	1.5	0.3	0.8	2.9
Music	4.1	4.0	7.6	4.4	3.9	1.2	1.8	1.3	3.5
News, special and current	49.2	44.2	6.0	39.3	29.8	32.0	32.5	38.2	33.4
Variety	17.1	11.8	9.7	3.2	11.3	16.5	15.3	10.7	11.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

It may be noted from the table that there are three major program types making up the greater part of the entire program fare. News, special events and current events, lead with 33.4 per cent of the total time. Drama shows 29.1 per cent, and educational-type programs, 17.0 per cent of the total. These three classifications account for 79.5 per cent of the total program time. However, in a more detailed breakdown, these three classifications cover 19 of the 29 minor classifications. From studies of audience reaction, these 19 classifications form the most logical and acceptable material. Most of the special-events and current-events topics are covered by the mobile-unit equipment,

with sports making up about half the program time picked up by this unit. To date, drama has been carried mainly by the live-talent studio, and educational material chiefly by film.

In addition to programs broadcast for the home audience, a "test signal" was furnished for television dealers and service men to aid in their work of receiver installation and maintenance.

Month	Number of Hours of Test Signal
May	105.9
June	106.2
July	101.0
August	84.0
September	73.5
October	48.0
November	55.0
December	57.5
Total (8 months)	631.10

or an average of about 18 hr. a week for 35 weeks.

This 631.10 hr. of test signal plus the 361.87 hr. of program material makes a total of 992.97 for the 8 months, or an average of 28.37 total hours of signal a week on the air for the industry to test, install, and service television receivers in the field.

For the week of Oct. 1 to 7, NBC, during its television programs, offered to send television schedules to all television-set owners who submitted their names and addresses by mail. A letter was mailed with the first program schedule, requesting data on the type of receiver as well as detailed comments at any time. The object of mailing out the program schedules was to compile a file of set owners and to work toward obtaining audience reaction to programs. The first week, 249 schedules were mailed. On the fourteenth mailing, Jan. 7, 1940, this list increased to 1,005 set owners.

There have been a few opportunities to check what percentage of the total set owners requested program schedules. A distributor in New Jersey sent in his complete list of set owners. When this list was checked against the mailing list, it was found that only 33 per cent had written in to request the schedules. This and similar checks have indicated that the file lists between one-third and one-half of the total set owners. If these figures are used to project the figures above, the total number of sets in the field may be presumed to be around 2,000.

The file reveals 3.7 per cent of the sets installed in restaurants, taverns, and hotels; 6.5 per cent in stores, movie houses, schools, etc.; and 89.8 per cent in homes. In addition, there is a separate file of 289 television dealers in the New York metropolitan area who have television installations for public viewing.

Geographically, the file shows the following breakdown:

		Percentage of Total
Connecticut		5.7
New Jersey		28.3
New York		64.6
Bronx	3.1	
Brooklyn	11.2	
Manhattan	16.2	
Other	34.1	
Pennsylvania		1.4
Other		.7

Some of the more distant members of the audience are in such locations as: in the West, Willow Grove, Philadelphia, Meadow Brook, Langhorne, and Allentown, Pa.; to the North and Northeast, Bridgeport, Hartford, and Stamford, Conn., and Newburgh and Pougheepsie, N. Y.; to the South, in New Jersey, we have viewers as far away as Asbury Park and Haddonfield.

The data on receivers at this time indicate that 33.6 per cent of the receivers are equipped with a 12-in. receiving tube, 15.0 per cent with the 9-in. tube, 34.3 per cent with 5-in. and smaller tubes; and for 17.1 per cent of the receivers, there is no information as to tube size at this time.

Although there are no accurate data on the number of persons viewing per receiver, from audience mail, from first-hand observation, and from a limited survey during our field-test period prior to Apr. 30, 1939, it is felt there are on the average at least four or five persons per set; a survey is now being conducted to determine more reliably the average number of persons present at each receiver. Crowds in dealers' stores, movie houses, and other public television-display points are often three to four times this number. Regarding such facts simply as indications, a conservative estimate seems to be that the potential audience is in the neighborhood of 5,000 to 8,000 people at this date.

In response to the request for detailed criticisms of programs, about half the set owners on file responded. Some of the replies

were two and more pages long, containing suggestions and thoughts aimed to help NBC match its programs as closely as possible to audience desires. Since this first mailing, there has been an average of 39.3 per cent return of the reaction questionnaires, which, it is felt, shows a considerable interest in the programs on the part of the audience. In analyzing these return questionnaires, it was found that for a typical week, 87 per cent of the audience looked in at least one-half our total program hours on the air for that week, and 30 per cent viewed about 90 per cent of all the programs. It should be kept in mind that approximately 50 per cent of the programs are day shows and 50 per cent are in the evening.

Audience-viewing habits were analyzed by day and evening for every day of the week; it was found that the average of the number of people in the audience viewing the programs is over 50 per cent, and on Saturday and Sunday afternoon, around 70 per cent. The evening percentage rarely goes below 80 per cent. These percentages may be considered as indicative of the amount of use of receivers and the consistency of viewing from day to day. An additional interesting fact on the number of people viewing the programs at any one time is that, on one evening, there was the large audience of 96.2 per cent, as indicated by our postcard survey.

Through these postcard questionnaires, every television-set owner of the audience has an opportunity to voice his opinion as to the quality and acceptability of every individual program broadcast. It is believed that in offering this opportunity to the television audience and keeping thoughts and operations flexible, programs can be readily trimmed, as closely and as quickly as possible, to the majority vote of the audience. Many means of determining the reaction of our audience are employed and these are being constantly used as measuring rods to guide operating policy. It has been found that the average rating of all programs as obtained from these reaction cards has been a little over "good." Each week shows a steady climb in the audience rating. Over one 3-week period, the audience survey showed a 17 per cent increase in rating. Another measure of program quality consistency is the amount of spread between the highest and the lowest rated program. Over a 3-weeks period, the spread in rating between the highest and the lowest

show decreased from 63 to 44 per cent. In general, this survey shows (1) that our programs are becoming progressively better in all departments—studio, film, and outside pickup; (2) that the audience rates the programs a little better than good; (3) that programs are being produced with a more consistent quality.

In the first 8 months' period, a considerable amount of data has been gathered on costs of operation. The following conclusions have been established:

1. The costs are remaining quite constant from month to month, but the end results—the average audience rating of programs—have been steadily increasing.
2. Considering the fund of experience and experienced personnel being accumulated month by month, each dollar can be spent more wisely and effectively.
3. Basing one version of "efficiency" on the average cost per program-hour on the air gives the following story month by month:

Month	Taking May as 100 Per Cent, Percentage of May's Cost per Hour
May	100
June	62.4
July	56.4
August	40 6
September	56.8
October	53 3
November	45 0
December	49 3

In other words, the cost per hour in August was 40.6 per cent of that in May. Of course, there are many reasons for this, besides the one of getting more experience and knowledge of operation. For instance, one other factor is that of utilizing a given "unit crew" for the maximum number of hours possible in a work week, etc.

During the past 6 months' experimentation, NBC has ever been on the alert for answers to the question "How is television doing in respect to the possibility of supporting itself as a business venture?"

More than 5 years of active analysis and 8 months' practice in operation have furnished certain data based on accomplished

fact. The theorizing for the future, once nebulous but now being nurtured by experience and time, is ever becoming clearer and more practical.

NBC operated during the first 8 months, as did all television stations in the country, on its experimental license. However, for 3½ years prior to public service in April of 1939, a considerable amount of research had been conducted in the advertising aspects of television. In fact, programs were experimented with, which were considered suitable for advertising purposes, involving products of many different industries, using both live-talent studio shows and regular commercial film. There was a considerable amount of cooperation with a number of manufacturers and advertising agencies in the production of these shows.

All this, naturally, was done anticipating that television would eventually become an advertising medium. NBC could not plan an immediate sale of its television time, as is done in sound broadcasting, so, in the meantime, it busied itself creating as much program variety as possible in order to build a fund of experience which, it is hoped, will be of much value at such a time when television broadcasting is commercial.

NBC has made it a point to keep advertisers and advertising agencies constantly informed on the progress of television broadcasting. This service is and has been in the form of lectures, letters, monographs, personal meetings, and an open invitation to all qualified advertising men to visit the television plant and ask all the questions that they please. This open, flexible policy reaped excellent response, with the result that there is now a considerable file of information on the advertising potentialities of television broadcasting.

A word might be said here for the wisdom of permitting more or less unhampered experimental activity in respect to advertising-type programs; because by allowing the technique of presenting advertising programs to grow hand in hand with the technique of presenting sustaining programs, a rounded program service for the public is created. If television were to become suddenly commercial without actual experience in building shows for advertising, a patchwork program technique might result.

One phase of cooperation with the advertising industry was the issuance of an invitation to all advertising agencies to appoint a liaison post in each agency to act as a clearinghouse for

the agency on television matters with NBC. Along with this open policy with the advertising industry, an invitation was extended to them actually to work with NBC on its development program, during the experimental, noncommercial period.

Fifty-four different advertisers have cooperated on 95 individual programs during the past 6 months. It is interesting to note that the 54 represent 16 of the major industries.

The table that follows shows the percentage of total program hours used for experimental advertising programs from May to January. The fact that this percentage increased from 6.5 to 11.4 is indicative of the active interest that these advertisers have taken in the study of television as another advertising medium.

PERCENTAGE OF TOTAL TIME USED FOR EXPERIMENTAL ADVERTISING

Month	Percentage of Total Program Hours
May	6.5
June	8.4
July	8.6
August	13.1
September	15.8
October	13 9
November	11.6
December	11.4

The experimental advertising shows have been broadcast, using all three types of program facilities—studio, film, and outdoor. The summary of the 8 months showed that 32.5 per cent of the experimental advertising shows were produced in the studio, 50.9 per cent was commercial film, and 16.6 per cent was with the mobile unit. The audience reaction to these experimental advertising shows has been analyzed; and it was found that over a 3-week period of the survey, the audience rating increased 20 per cent. At this rate, it might be said that television advertising technique is improving, and our learning should be more rapid as time goes on.

Based on the years of technical research and the study made on television broadcasting as a business venture, along with the months of actual experience which have just ended, it is felt that the machinery, the philosophy, and the enthusiasm requisite for successful television broadcasting have been established.

APPENDIX I

"THE THREE GARRIDEBS"

A TYPICAL TELEVISION SCRIPT WITH PRODUCTION DIRECTIONS

In the general studio layout illustrated below four sets are shown, compressed within the confines of an area no larger than an ordinary high-school auditorium stage. This plan amplifies the first principle of television dynamics, which is *conservation of space.* In the ordinary theater play the scenes are shifted

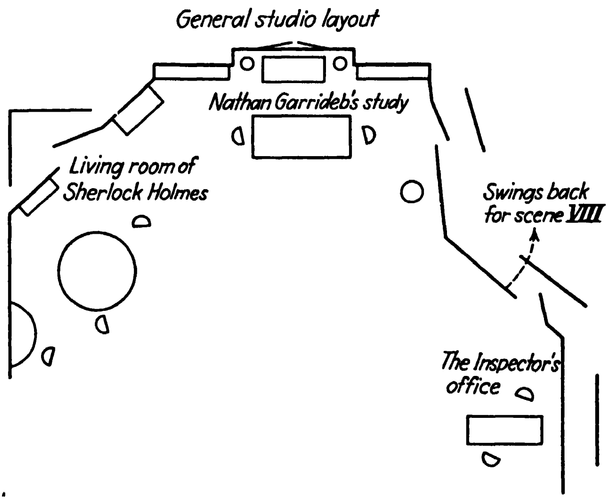


Fig. 73.—General studio layout for "The Three Garridebs," with four sets shown.

between acts; but in television, they are usually set in advance.

The second principle of television dynamics illustrated by "The Three Garridebs" arises from the use of moving-picture sequences, still pictures, sight effects, and scale models, in alternation with live action in the studio.

Briefly, the second principle postulates that *continuity must be maintained* against all hazards and at all costs. The continuity of theater drama can be broken by one or more intermissions. The continuity of film drama is not real, because it involves a

series of "takes" spread out over a period of days, weeks, or months. The takes are assembled in a film cutting room by an editor who joins the proper sequences into a running story.

Where stage technique requires an intermission for scene shifting, television allows the producer to introduce a film sequence or a still picture. The continuous camera action in television broadcasting may be compared to the old Greek marathons where the runners passed the torch from one to another and kept it moving constantly. Similarly, if one camera is ordered to move from one position to another, it "passes the torch" to a neighboring camera, which in turn may hand it on to a third camera or perhaps to a motion-picture projector.

In the preparation of the script of "The Three Garridebs," the producer called for projector slides showing a "Picture of London—Big Ben and Bridge," a "name plate," a "newspaper ad," and two minutes of moving-picture film as described in the script on page 58.

Scene II calls for a moving-picture sequence involving a horse, a hansom cab, and two of the principal characters. Such slides and films are characteristic television devices, and they may be inserted at convenient intervals in the action of a play, affording actors an opportunity to walk from one scene to another and to change their costumes en route. Of course, slides or films need not necessarily be inserted to cover a break in the live action. They may be indispensable to the plot or story continuity.

The third principle of television dynamics illustrated by "The Three Garridebs" states the general requirement for *mobility of drama*. Mobility is an accepted principle mainly because the soul of drama is action. We have noted before that the eye is more critical and less patient than the ear; it feeds on any action that arrests it.

The problems of achieving mobility in television are more closely related to the movies than to the theater. There are various methods of achieving it, usually used collectively in some combination: Keep actors moving; employ a story that demands action for its development; employ camera action by alternate switching of cameras, by introducing moving-picture sequences, sight effects, diagrams, and still pictures. The object is to hold the televiewer's attention and to keep the play action from slowing down or appearing static.

Television must employ this dynamic principle more consistently and more intensively than the moving pictures, mainly because the television screen at present is much smaller than the cinema screen, and fewer details of action or facial expression can be discerned. So television drama must use numerous close-ups to register the facial animation, expression, and reactions of the actors.

In "The Three Garridebs" script there are numerous instances of television mobility. Very often as many as five camera changes occur within a minute. At no place in the play does one camera televise the action for longer than half a minute. In addition to camera mobility, mobility is introduced by motion-picture and still-picture projectors and also by sight effects.

"The Three Garridebs" was successful television material because it is built around bold action and dramatic suspense, both of which are vital to television entertainment. In all, no less than six different locales contribute to making the play appealing to the eye. Besides, there is a clever interplay of physical activity and mental stimulation. Sherlock Holmes discovers clues and deduces the motivations of an archcriminal. In the end the sleuth may be seen in his familiar costume, chasing down the various clues and finally trapping the lawbreaker in the act of committing a crime.

In the original shooting script of "The Three Garridebs," cues and directions to camera #1 were underlined in red pencil, and cues to camera #2 were underlined in blue. A combination of red and green lines underlined all music cues. A single green line underlined cues for sight effects. For typographical reasons, the script as printed here must make use of a different notation. In the script proper, cues for camera #1 are indicated by a single line, underlining the words on which the camera is switched into action. Similarly, cues for camera #2 are indicated by a double underlining. A wavy underline indicates cues for sight effects, and a combination of straight and wavy underlining indicates music cues.

The camera instructions, at the right-hand margin of each page, are arranged as follows: The switching instructions that correspond to the switching cues are underlined in corresponding fashion. The instructions to the inactive camera (instructions to be followed by each camera after it is switched off the scene)

are indicated in *italics*. Instructions to the active camera are printed in ordinary (Roman) type but are not underlined unless the instructions are to be followed on cue. In the latter case the underlining corresponds to the cue in the script.

THE THREE GARRIDEBS*

MUSIC ALL THROUGH OPENING

OPENING SHOT ON TITLE DISPLAY SHOWING DUSTY BOOK SHELF WITH ONE PROMINENT BOOK CENTER, LYING IN A POSITION TO SHOW FRONT COVER. TITLE OF BOOK, "SHERLOCK HOLMES." TITLE MOVES TOWARD CAMERA UNTIL THE BOOK OCCUPIES THE ENTIRE PICTURE. BOOK OPENS REVEALING — CAMERA #2

Page One—The National Broadcasting Company Presents — *#1 ready for first scene*

PAGE TURNS

Page Two—The Adventure of the Three Garridebs

PAGE TURNS

Page Three—Adapted for Television by Thos. H. Hutchinson

PAGE TURNS

Page Four—From the story by A. Conan Doyle

PAGE TURNS

Page Five—Cast

Sherlock Holmes. Louis Hector
Doctor Watson. . . William Podmore

PAGE TURNS

Page Six John Garrideb Arthur Maitland
Nathan Garrideb. James Spottswood

* Thanks are due to Lady Doyle for permission to publish the television version of "The Adventure of the Three Garridebs" by the late Sir Arthur Conan Doyle; also to the Ryerson Press of Toronto, Canada; and to Doubleday, Doran & Company, Inc., of New York. "The Adventure of the Three Garridebs" is from "The Case Book of Sherlock Holmes," copyright 1927 by Doubleday, Doran & Company, Inc. Television script copyright 1940 by the National Broadcasting Company, Inc.

FIG. 74.—Opening shot—title display. Eight leaves of book turn, revealing introductory information.

PAGE TURNS

Page Seven Mrs. Hudson. . . . . . Violet Besson
 Mrs. Saunders. . . . Selma Hall

PAGE TURNS

Page Eight Inspector Lestrade. . Eustace Wyatt

(FADE OUT TITLE)

(FADE IN)

(LEICA SLIDE OF BIG BEN) #3*

* Camera #3 operated from the motion-picture studio (studio 5A).

SCENE I

(FADE OUT)

(FADE IN)

(MUSIC STOP)

CAMERA #1
FULL SHOT OF SHERLOCK HOLMES' RECEPTION ROOM

DR. WATSON IS STANDING LOOKING OUT WINDOW. DOOR AT LEFT OPENS, AND HOLMES ENTERS IN DRESSING GOWN WITH FOOLSCAP DOCUMENT IN HIS HAND

HOLMES

Friend Watson. Have you ever heard of Garrideb?

#1 DOLLIES IN FOR MEDIUM SHOT OF THE TWO MEN INCLUDING TELEPHONE STAND

WATSON

Garrideb? What on earth is it?

HOLMES

A name—a man's name—Garrideb. If you can lay your hand on a Garrideb, Watson, there's money in it.

#2 movies in, ready for close-up of Holmes and Watson

WATSON

In heaven's name, Holmes, what are you talking about?

HOLMES

Crossing down to table center
Fills pipe at tobacco jar on table
Oh, that's a long story—rather a whimsical one too. I don't think in all our explorations of human complexities we have ever come upon anything more singular.

WATSON

Turning to stand right of door
Sounds interesting.

HOLMES

The fellow will be here presently for cross-examinations, so I won't open the matter up until he comes, but meanwhile that's the name we want.

WATSON

Looks through telephone directory on stand as Holmes lights his pipe
Holmes! (*Crossing down to Holmes*) Here it is in the telephone book. SWITCH TO #2 CLOSE-UP OF HOLMES AND WATSON

HOLMES

Taking book from Watson. Reading
Garrideb, N. 136 Little Ryder Street, West. (*Putting book back*) Sorry to disappoint you, my dear Watson, but this is the man himself. That is the address on his letter. We want another to match him. *#1 holds* SWITCH TO #1

WATSON

Match him? *#2 pans to close-up of Mrs. Hudson and Watson*

HOLMES

Exactly. (*Knock on door center*) Come in. (*Sits left of table*)

MRS. HUDSON

Entering with card
There is a gentleman here to see you, Mr. Holmes. SWITCH TO #2

WATSON

Taking card from tray. Amazed
Why, here he is. But this is a different initial. John Garrideb, counselor-at-law, Moorville, Kansas, U.S.A. (*Hands card to Holmes*) *#1 holds* SWITCH TO #1 HOLDS ON DOOR

HOLMES

I'm afraid you must make another effort, Watson. Show him in, Mrs. Hudson. #1 DOLLIES BACK

MRS. HUDSON

Yes, sir. (*Exits center*)

WATSON

But why if he's here now—

FIG. 75.—Mrs. Hudson announcing Mr. John Garrideb as viewed on a television receiver.

HOLMES

Rising crosses to right of table
This gentleman is also in the plot already, though I certainly didn't expect to see him this morning. However, he is in a position to tell us some of the things we want to know.

#2 holds on door

SWITCH TO #2 ON MRS. HUDSON AND JOHN

MRS. HUDSON

Entering door center
Mr. John Garrideb.

JOHN

#1 back for all three people

Entering door center and crossing to table
Mr. Holmes? (*Mrs. Hudson exits. Looking from one to the other*) Oh, yes. (*Crossing to left of table*) Your pictures are not unlike you, sir, if I may say so.

#2 PANS WITH JOHN

HOLMES

SWITCH TO #1

Thank you.

JOHN

I believe you have had a letter from my namesake Mr. Nathan Garrideb, have you not?

HOLMES

#2 moves in for close-up of John standing

Pray sit down. (*Indicating chair left of table*) May I introduce my colleague Dr. Watson?

WATSON

How do you do? (*Back of table*)

JOHN

Sitting left of table
How do you do.

HOLMES

I fancy we have a good deal to discuss. (*Looking at letter*) You are, of course, the Mr. John Garrideb mentioned in this letter?

JOHN

Yes, I am.

HOLMES

But surely you have been in England some time.

JOHN

Suspiciously
Why do you say that, Mr. Holmes?

HOLMES

Your whole outfit is English.

JOHN

Forcing a laugh
I have read of your tricks, Mr. Holmes, but I never thought that I would be the subject of them. Where do you read that?

HOLMES

The shoulder cut of your coat, the toes of your boots—could anyone doubt it?

SWITCH TO #2 ON JOHN

JOHN

Well, I had no idea I was so obviously a Britisher. Business brought me over here some time ago, and so, as you say, my outfit is nearly all London made. (*Bruskly*) However, I guess your time is of value, and we did not meet to talk about the cut of my socks. What about getting down to that paper you hold in your hand?

#1 holds

SWITCH TO #1 ON TWO MEN

HOLMES

Dr. Watson would tell you that these digressions of mine sometimes prove in the end to have bearing on the matter in hand. But why did Mr. Nathan Garrideb not come with you?

JOHN

#2 pans to Holmes

With sudden anger

Why in thunder did he draw you into it at all? A bit of professional business between two gentlemen.

SWITCH TO #2 ON HOLMES

HOLMES

There is no reflection upon you, Mr. Garrideb. He knew that I had means of getting information, and it was only natural that he should apply to me.

#1 holds on Holmes and John

SWITCH TO #1

JOHN

Forgive me, Mr. Holmes. When I went to see him this morning he told me that he had called in a detective, and I don't want police butting into a private matter. But if you are willing just to help us find the man, I would be very happy to have you.

HOLMES

#2 on John medium shot as he sits

Thank you. And now, we would like a complete account from your own lips. My friend here knows nothing of the details.

JOHN

Looking at Watson

Does he need to know?

HOLMES

We usually work together.

Fig. 76.—Holmes and John Garrideb at table. Camera #1, on the left, "takes in" both men, and camera #2 takes close-ups of either man.

JOHN

Well, there is no reason it should be kept a secret. I'll give you the facts as concisely as I can. (*John sits*) If you came from Kansas I would not need to explain to you who Alexander Hamilton Garrideb was. He made his money in the wheat pit in Chicago, but he spent it in buying up as much land as would make one of your counties, lying along the Arkansas River, west of Fort Dodge. He had no kith or kin—or if he had, I never heard of them. But he took a kind of pride in the queerness of his name. That was what brought us together. I was practicing law in Topeka, and one day I had a visit from the old man.

SWITCH TO #2 ON JOHN

#1 holds on all three

SWITCH TO #1

#2 in for close-up of John (very close)

HOLMES

Alexander Hamilton Garrideb?

JOHN

Right. He was tickled to death to meet (*Holmes moves chair down and to center*) another man with his own name.

SWITCH TO #2

It was his pet fad, and he was dead set to find out if there were any more Garridebs in the world and wanted me to find him another. I told him I was too busy to spend my life hiking around the world in search of Garridebs. But that's just what you will do, he said, if things pan out as I have planned. I thought he was joking, but I soon discovered that he wasn't. He died within a year and left behind him the queerest will that has ever been filed in the state of Kansas. Under its terms, his property was divided into three parts, and I was to have one on condition that I found two Garridebs who would share the remainder. It's five million dollars for each of us if it's a cent, but we can't lay a finger on it until we all three stand in a row.

#1 moves to left to get John over Holmes shoulder

SWITCH TO #1

WATSON

A sort of a fifteen million dollar game of tit-tat-toe.

#2 pulls back—still on John

JOHN

It was so big that I let my legal practice slide and began looking for Garridebs. There's not one in the United States. I went through it with a fine-tooth comb. Then I tried the old country. In the London telephone directory I found a Garrideb. I went to see him two days ago and explained the whole matter to him. But he is a lone man like myself with some women relatives but no men. It says three adult men in the will, so you see we still have a vacancy; and if you can help to fill it, we will be willing to pay your charges.

SWITCH TO #2

#1 back right for the three men

HOLMES

Well, Watson, I said it was rather whimsical didn't I? (*To John*) I should have thought that your obvious course of procedure was to advertise in the paper.

SWITCH TO #1

#2 pans to Holmes

JOHN

I have done that, Mr. Holmes, with no replies.

SWITCH TO #2

HOLMES

Well, Mr. Garrideb, it certainly is an interesting little problem. I may take a glance at it. By the way, it's curious that you should have come to me from Topeka.

FIG. 77.—Scene as viewed on television receiver just before John Garrideb (right) exits. Holmes is on the left; Dr. Watson in center. This is the long shot on camera #1.

I used to have a correspondent there—he's dead now—old Dr. Lysander Starr. He was a mayor in the nineties. *#1 back for John's rise*

JOHN

Did you know Dr. Starr? That is a coincidence. He's still talked about in Topeka. (*Rising*) Well, Mr. Holmes, I suppose all we can do is to report to you and let you know how we progress. I reckon you'll hear within a day or two. SWITCH TO #1

HOLMES

We will be expecting your call. You can find your way out? #1 BACK TO WATSON AND HOLMES

JOHN

Of course. (*Crossing to door*) Good day, Mr. Holmes. (*Exits door center*)

WATSON

Well. (*Crosses to Holmes who is seated in chair center*)

HOLMES

I'm wondering, Watson, just wondering.

WATSON

At what? (*Crossing to back of table*) *#2 pans for close-up of Holmes*

HOLMES

I'm wondering, Watson, what on earth could be the object of this man in telling us such a rigmarole of lies. I nearly asked him, but I judged it better to let him think he had fooled us.

WATSON

How did you know he was lying? (*Sits left of table*)

HOLMES

Elemental, my dear Watson, elemental. Here is a man with an English coat—frayed at the elbow and trousers bagged at the knee with a year's wear—and yet by this letter and by his own account, he is a provincial American lately landed in London. There have been no advertisements in the paper. I never knew a Dr. Lysander Starr of Topeka. Touch him where you would, he was false. I think the fellow is really an American, but he has worn his accent smooth with years in London.

SWITCH TO #2 CLOSE-UP ON HOLMES

#1 holds on both

SWITCH TO #1

WATSON

What's his game then, and what motive lies behind this preposterous search for Garridebs? (*Rise to window*) *#2 pans telephone*

HOLMES

That's the question, Watson, and it's worth our attention, for, granting that the man is a rascal, he is certainly a complex and ingenious one. We must now find out if our other correspondent is a fraud also.

WATSON

But how? READY FILM

HOLMES

Ring him up.

WATSON

Crossing to telephone on table. SWITCH TO #2
Getting number from book. Picks up phone
Newgate 6583.—Hello—Mr. Nathan Garrideb? Sherlock Holmes calling. Just a moment please. (*To Holmes*) He wants to talk to you. (*Holmes crosses to phone*)

HOLMES

At phone
Yes. Yes, he's been here. Will you be at home this evening, Mr. Garrideb? I suppose your namesake will not be? Very well, we'll come round then, for I'd rather have a chat with you without him. Dr. Watson will come with me. About six. You needn't mention our visit to the American lawyer. *Start film projector*

(FADE OUT)

(PROPERTY MEN LAY TABLE CLOTH AND SILVER, ETC., FOR NEXT SCENE)

(FADE IN. FILM) FADE IN ON #3

SCENE II

HOLMES AND WATSON RIDING IN HANSOM CAB. CAB COMING TO STOP AT CURB. CLOSE SHOT OF MEN AND CAB AS IT STOPS *#1 dollies for two men at door in hall*

HOLMES

Well, Watson, we seem to have arrived.

WATSON *#2 dollies to Nathan at table*

Right. Little Ryder Street West and there is number 136. (*Looking at house*)

HOLMES

Looking at watch
And right on time. Six o'clock to the minute. (*They get out of cab. Watson pays cabby*) *Ready on name plate #3*

WATSON

To driver
You needn't wait.

(CABBY TOUCHES HIS HAT AND DRIVES OFF. SHOT OF HOUSE FROM CURB. HOLMES AND WATSON START INTO HOUSE)

HOLMES

Let's see if our friend Mr. Garrideb is at home.

WATSON

Right.

(THEY ENTER FRONT DOOR)

(AS DOOR CLOSES . . .) SWITCH TO CAMERA #1 ON THE TWO MEN AT HALL DOOR

(CUE MEN)

SCENE III

HALLWAY OUTSIDE GARRIDEB'S DOOR

WATSON

Apparently we are in the right house. Here's his name plate. SWITCH TO #3

(CLOSE SHOT OF NAME PLATE READING "NATHAN GARRIDEB")

HOLMES *#1 holds*

That name plate has been up some years, Watson. SWITCH TO CAMERA #1 ON THE TWO MEN

WATSON

I deduced that myself from the condition of the discolored brass surface.

HOLMES

Splendid, Watson. And it's his real name, anyhow. That is something to note. (*He rings the door bell*)

SCENE IV

BELL HEARD RINGING SWITCH #2

INTERIOR OF NATHAN GARRIDEB'S ROOM. TO ALL APPEARANCES A SMALL MUSEUM.

CUPBOARDS AND CABINETS ON ALL WALLS. CASES OF BUTTERFLIES, STUFFED BIRDS. TABLE CENTER WITH MICROSCOPE. CASE OF ANCIENT COINS. PLASTER SKULLS. FOSSIL BONES AND DEBRIS ON TABLE. CHAIRS RIGHT AND LEFT OF TABLE. DOOR LEFT, LARGE WINDOW CENTER. NATHAN SEATED AT RIGHT OF TABLE CENTER STUDYING OBJECT THROUGH MICROSCOPE. AS BELL RINGS THIRD TIME HE RISES, CROSSES TO DOOR, AND OPENS IT. HALLWAY DOOR IS MOVED TO COMPLETE LESTRADE'S OFFICE. DESK AND TWO CHAIRS ARE PLACED

#1 dollies for full shot of Nathan's room

SWITCH TO #1

DOOR BELL

NATHAN

Yes?

#2 on Holmes at table center

HOLMES

Outside door
Mr. Nathan Garrideb?

NATHAN

Yes, and you are Sherlock Holmes?

HOLMES

I am. And this is Dr. Watson.

NATHAN

Come in, gentlemen. (*They come into the room*)

HOLMES

Well, Mr. Garrideb, quite an interesting place you have here.

NATHAN

Yes, I have around me all my little interests in life.

SWITCH TO #2 ON HOLMES

HOLMES

Crossing down to back of table and picking up coin
Ah, Syracusan, isn't it?

#1 holds on room

NATHAN

Coming to his left
Of the best period. They degenerated greatly toward the end. At their best I hold them supreme, though some prefer the Alexandrian school. (*Indicating chair right of table*) Take that chair, Mr. Holmes, and pray allow me to clear these bones. (*To Watson who is examining skull at left of table*) You find that interesting, doctor?

SWITCH TO #1
#2 on Watson
SWITCH TO #2

WATSON

#1 holds

Very.

NATHAN

If you don't mind, I'll remove that vase, doctor. (*Indicating vase in chair left of table. Nathan takes vase from chair and places it on cabinet up left and stands center. Watson sits left*)

SWITCH TO #1 ON THREE

HOLMES

I take it you spend a great deal of your time in this room, Mr. Garrideb.

NATHAN

I do. My doctor lectures me about never going out, but why should I go out when I have so much to interest me here? I can assure you that the adequate cataloguing of one of these cabinets would take me three good months.

#2 in for close-up of Nathan

HOLMES

SWITCH TO #2 ON NATHAN

Do you mean to tell me that you never go out?

NATHAN

Very seldom. But you can imagine, Mr. Holmes, what a terrific shock—pleasant but terrific—it was for me when I heard of this unparalleled good fortune. It only needs one more Garrideb to complete the matter, and surely we can find one. I had a brother, but he is dead; but there surely must be others in the world. I had heard that you handled strange cases, and that was why I sent for you.

#1 dollies in for medium shot on Holmes

SWITCH TO #1

HOLMES

I think you acted very wisely. But are you anxious to acquire an estate in America? *#2 in for close-up of Nathan*

NATHAN

Certainly not, sir, nothing would induce me to leave my collection. But this gentlemen has assured me that he will buy me out as soon as we have established our claim. SWITCH TO #2
Five million dollars. There are a dozen specimens in the market which fill gaps in my collection that I am *#1 holds*
unable to purchase for want of a few hundred pounds. Just think what I could do with five million dollars. Why, I will have the nucleus of a National Collection. SWITCH TO #1

HOLMES

Rising and crossing up center
I merely called to make your acquaintance, as I prefer to establish personal touch with those with whom I do business. I understand that up to this week you were *#2 pulls back to get both at cabinet*
unaware of our American friend's existence. (*Watson rises and crosses left and examines cabinet*)

NATHAN

Crossing up center to Holmes
Yes, he called for the first time last Tuesday. SWITCH TO# 2

HOLMES

Did he tell you of our interview this morning?

NATHAN

Yes, he came straight back to me. He had been very angry.

HOLMES

Why should he be angry?

NATHAN

He seemed to think that it was some reflection on his honor! But he was quite cheerful again when he returned.

HOLMES

Did he suggest any course of action?

NATHAN

No, sir. He did not.

HOLMES

Has he ever asked for any money from you? *#1 holds*

NATHAN

No, sir, never.

HOLMES

You see no possible object he has in view?

NATHAN

None, except what he states.

HOLMES

Did you tell him of our telephone appointment?

NATHAN

Yes, sir, I did.

HOLMES

Looking about room
Have you any articles of great value in your collection? #2 PULLS BACK TO INCLUDE THE FOUR MEN

NATHAN

No, sir, I am not a rich man. It's a good collection but not a very valuable one.

HOLMES

You have no fear of burglars. SWITCH #1

NATHAN

Not the least. *Ready #3*

HOLMES

How long have you been in these rooms?

NATHAN

Nearly five years. #1 PANS TO DOOR WITH NATHAN

DOOR BELL. BELL IS HEARD ON DOOR LEFT

Watson crosses extreme right. Nathan crosses to door and opens it. John enters greatly excited with newspaper in his hand. He crosses to center

JOHN

To Nathan who follows him center
Here you are. I thought I'd be in time. Mr. Nathan Garrideb, my congratulations. You are a rich man. Our business is finished, and all is well. As to you, Mr. Holmes, we can only say we are sorry if we have given you any useless trouble. SWITCH TO #2 ON THE THREE MEN

NATHAN

But what is it? What do you mean?

JOHN

This. This advertisement in a Birmingham newspaper. SWITCH TO #3
(*Holmes, Watson, and Nathan look at paper*)

(SWITCH TO CLOSE SHOT OF FOLLOWING NEWSPAPER AD)

HOWARD GARRIDEB *#1 dollies in on Holmes, John, and Nathan*

Binders, reapers, steam and hand plows,
drills, harrows, farmer's carts, buckboards
and all other appliances.
Estimates for Artesian Wells
Apply Grosvenor Building, Aston. SWITCH TO #2 ON THE THREE MEN

NATHAN

That makes our third man. How did you find it?
(*Holmes hands paper to Watson on his right*)

JOHN

I had opened up inquiries in Birmingham, and my agent SWITCH TO #1
there sent me this advertisement from a local paper. We must hustle and put this thing through. I have written to this man and told him that you will see him in his office tomorrow afternoon at four o'clock. *#2 in for close-up of John and Nathan*

FIG. 78.—The scene as it appeared from the close-up of John and Nathan on camera #2.

NATHAN

You want me to see him?

JOHN

What do you say, Mr. Holmes? Don't you think it would be wiser? Here I am, a wandering American with a wonderful tale. Why should he believe what I tell him? But you are a Britisher with solid references, and he is bound to take notice of what you say. I could go with you, but I have a very busy day tomorrow, and I could always follow you if you get in any trouble.

SWITCH TO #2 ON JOHN AND NATHAN

NATHAN

I haven't made such a journey in years. (*Crosses to chair left of table and sits*)

#1 holds

JOHN

It's quite simple, Mr. Garrideb; I have figured out your train connections. You leave at twelve and should be

there shortly after two. Then you can be back the same night. All you have to do is to see this man, explain the matter, and get an affidavit of his existence. Considering that I have come all the way from the center of America it surely is little enough if you go a hundred miles to put this matter through. SWITCH TO #1 ON THE THREE MEN

NATHAN

Disconsolately

Well, if you insist, I shall go. It certainly is hard for me to refuse you anything, considering the glory of hope that you have brought into my life. *#2 for Nathan and Holmes*

HOLMES

Then that is all agreed, and no doubt you will let me have a report as soon as you can.

JOHN #1 PANS WITH JOHN TO DOOR

I'll see to that. Well, (*Looking at watch*) I'll have to get on. (*Nathan rises. Crosses to door*) I'll call tomorrow, Mr. Garrideb, and see you off to Birmingham. (*At door*) Coming my way, Mr. Holmes?

HOLMES

Not just yet.

JOHN

Well, good-bye then, and we may have good news for you tomorrow night. (*Exits door left*)

NATHAN

Five million dollars. SWITCH TO #2 ON NATHAN AND INCLUDE HOLMES

HOLMES

I wish I could look over your collection, Mr. Garrideb. In my profession all sorts of odd knowledge is useful, and this room of yours is a storehouse of it.

NATHAN

I have always heard, sir, that you were a very intelligent man. I'd be glad to show it to you now, if you have the time. *#1 holds on Holmes and Nathan*

FIG. 79.—Camera #2 close-up of Holmes and Nathan speaking. Photo from receiver screen.

HOLMES

Unfortunately I haven't. But these specimens of yours are so well labeled and classified that they hardly need your personal explanation. If I should be able to look in tomorrow, I presume you would have no objection to my glancing over them.

NATHAN

None at all. You are most welcome, Mr. Holmes. The place, of course, will be shut up, but Mrs. Saunders is in the basement up to four o'clock and will let you in with her key. SWITCH TO #1

HOLMES

Thank you. I happen to be clear tomorrow afternoon; and if you would say a word to Mrs. Saunders, I would appreciate it. By the way, who is your house agent?

NATHAN

House agent?

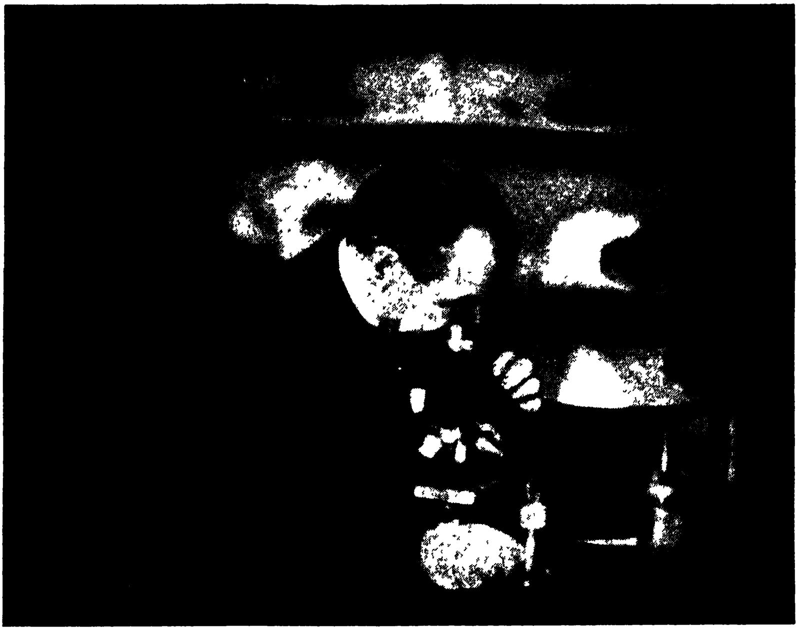


FIG. 80.—Dr. Watson as seen via television, while absorbed by Nathan's microscopic specimens.

HOLMES

Yes. *#2 on Watson*

NATHAN

Holloway and Steele in the Edgeware Road. But why do you ask? #1 PANS TO DOOR WITH HOLMES

HOLMES

Laughing
I am a bit of an archaeologist myself when it comes to houses. I was wondering if this place was Queen Anne or Georgian.

NATHAN

Georgian, beyond a doubt.

HOLMES

At door left with Nathan
Really, I should have thought a little earlier. Come Watson. (*Watson is seated at table examining object* SWITCH TO #2 ON WATSON

through microscope in same attitude as Nathan was in opening scene) — *#1 holds*

WATSON

Oh, yes, of course. (*Crossing to Holmes at door*) Excellent microscope you have there, Mr. Garrideb. — SWITCH TO #1 AT DOOR

NATHAN — *#2 on Nathan for close-up*

Yes, isn't it?

READY MUSIC

HOLMES

Well, good-bye, Mr. Garrideb, may you have every success in your Birmingham journey. (*Opens door. They exit*) — SWITCH TO #2 ON NATHAN

NATHAN*

One million pounds. (*Crossing down to camera for close-up*)

(FADE SCENE) (FADE IN MUSIC) — *#1 pans over for Holmes and Watson in Holmes' study*

(FADE IN HOLMES' STUDY) — SWITCH TO #1 ON ALL THREE

SCENE V

TABLE CENTER IS COVERED WITH WHITE TABLECLOTH, HOLMES RIGHT OF TABLE AND WATSON LEFT ARE JUST FINISHING DINNER. MRS. HUDSON IS SERVING DEMITASSE, CHEESE, AND CRACKERS — *#2 close-up of Mrs. Hudson*

†CLOCK STRIKES SEVEN

(FADE MUSIC) — READY #3

MRS. HUDSON

And will you be wantin' anything else, Mr. Holmes?

* This line and the business of Nathan crossing to table were inserted to enable camera #2 to close the scene, so that camera #1 might dolly in to take opening of next scene. Camera #1 has a wide-angle lens, and hence can take in the whole scene, thereby establishing the locale in Holmes' study.

† The clock striking and business of Mrs. Hudson serving tea were introduced to allow time for camera #2 to swing into position ready for close-up.

FIG. 81.—Monitoring screens in the studio control room. On the left, camera #1, scene of Dr. Watson and Mrs. Hudson, which is "on the air," and on the right the "preview" of camera #2 on Inspector Lestrade, ready to be switched "on the air" on cue from the program producer.

HOLMES

No thanks, Mrs. Hudson. This repast should satisfy the cravings of the inner man until breakfast time tomorrow morning, eh Watson? SWITCH TO #2 ON MRS HUDSON AND WATSON

WATSON

Undoubtedly, and if you will permit me, Mrs. Hudson, I would like to state a deduction I have just made. *#1 Holmes Watson*

MRS. HUDSON

Of course, Dr. Watson.

WATSON

After eating this dinner I am convinced without a doubt that Mrs. Hudson is the best cook in all London.

MRS. HUDSON

Beaming
I think it's a bit of the blarney you're handing me, Dr. Watson. (*Exits door center*) SWITCH TO #1 ON HOLMES CLOSE-UP

HOLMES

Sipping coffee

Well, Watson, our little problem draws to a close. No doubt you have outlined the solution in your own mind.

#2 dollies for close-up of Lestrade's desk, showing clock and phone

WATSON

Solution? I can make neither head nor tail of the case.

HOLMES

The head is surely clear enough, and the tail we should see tomorrow. Did you notice anything curious about that advertisement in the Birmingham paper?

SWITCH TO #3 FOR NEWSPAPER AD

WATSON

I saw that the word plough was misspelled P-L-O-W—instead of P-L-O-U-G-H as it should have been.

#1 holds

HOLMES

Oh, you noticed that, did you? Watson, you improve all the time. Yes, it was bad English but good American. The printer had set it up as received. Then the buckboards. That is American also. And artesian wells are commoner with them than with us. It was a typical American advertisement, but purporting to be from an English firm. What do you make of that?

SWITCH TO #1 ON HOLMES AND WATSON

DOLLY IN IF NECESSARY

WATSON

I can only suppose that this American lawyer put it in himself. What his object was I fail to understand.

HOLMES

Well, there are alternative explanations. Anyhow, he wanted to get this good old fossil up to Birmingham. That is very clear. I might have told him that he was clearly going on a wild-goose chase, but, on second thought, it seemed better to clear the stage by letting him go. Tomorrow, Watson—well tomorrow will speak for itself.

(FADE OUT SCENE)

(PROPERTY MEN: SET ROOM FOR NEXT SCENE)

(FADE IN INSPECTOR LESTRADE'S OFFICE)

FIG. 82.—Camera #2, close-up on Lestrade's office, right. At upper left can be seen Holmes' living room with property man clearing dinner table. Upper center is Nathan Garrideb's study.

SCENE VI

INSPECTOR SEATED AT DESK. DESK CLOCK SHOWS 9:45	SWITCH TO #2 CLOSE-UP AT DESK PAN TO LESTRADE
TELEPHONE RINGS AT OPENING OF SCENE	*#1 dollies to door of Lestrade's office*

LESTRADE

Picking up phone
Scotland Yard. Yes—Speaking—Yes. I'll send a man over. (*Hangs up phone. Door opens and Holmes enters with photograph in his hand. Comes to front of desk and sits*) Ah, Holmes, find what you were looking for?

SWITCH TO #1 ON HOLMES PAN WITH HIM TO DESK
#2 holds close-up on Lestrade

HOLMES

I think so, Inspector.

LESTRADE

Well, that's a nice way to start the day. To have found what you were looking for by ten o'clock in the morning.

HOLMES

I enjoy the early morning hours but I still have some way to go before I find what I'm looking for.

LESTRADE

And that is?

HOLMES

I have been trying to learn something about Mr. John Garrideb, counselor-at-law. #1 PANS TO INCLUDE BOTH MEN

LESTRADE

Never heard of him.

HOLMES

Neither had I until yesterday. But from the gentleman's actions I thought it might be possible that you had met him under another name.

LESTRADE

And you found this Mr. Garrideb in the Rogues' Gallery.

HOLMES

Either him or his twin brother. What do you think of my chubby faced friend (*Passing photograph to Lestrade*) SWITCH TO #2 ON LESTRADE NOT TOO CLOSE

LESTRADE

Looking at it

James Winter, alias Morecroft, alias Killer Evans. (*Turning photograph over—reading*) Age 44. Native of Chicago. Known to have shot three men in the states. Escaped from penitentiary through political influence. *#1 dollies for door of Holmes' study* Came to London in 1893. Shot a man over cards in a night club in Waterloo Road. January, 1895. Man died but was shown to have been the agressor. Dead man identified as Roger Prescott famous as forger and coiner in Chicago. Killer Evans released in 1901. Has been under police supervision since but so far as known has led an honest life. Very dangerous man—usually carries arms and is prepared to use them. (*To Holmes*) You have found that our friend Killer Evans has decided to stop leading an honest life?

HOLMES

I'm not sure, but I must admit that I am rather anxious to find out. *#2 to Holmes*

LESTRADE

Well, if we can be of any service, Mr. Holmes—

HOLMES

You have been, Inspector, in letting me look over your Rogues' Gallery.

LESTRADE

If we can be of any further assistance— #2 PAN WITH HOLMES AS HE EXITS

HOLMES

Rising
I'll call you. Thank you, Inspector, and good day. (*Exits*)

(FADE OUT SCENE)

(FURNITURE IN LESTRADE'S OFFICE IS STRUCK. DOOR IS STRUCK. TWO FLATS MOVED TO COMPLETE LOWER LEFT CORNER OF NATHAN'S ROOM, CLEARING VIEW OF CELLAR)

SCENE VII

FADE IN HOLMES' STUDY

WATSON ENTERS DOOR CENTER FOLLOWED BY MRS. HUDSON SWITCH TO #1 ON WATSON AND MRS. HUDSON

MRS. HUDSON

Mr. 'Olmes ain't in, doctor. He went out after breakfast and I ain't seen 'ide nor 'air of him since. *#2 close-up of Holmes*

WATSON

I'll wait if you don't mind.

MRS. HUDSON

Of course not. You know, doctor, Mr. 'Olmes' 'ome is almost your 'ome.

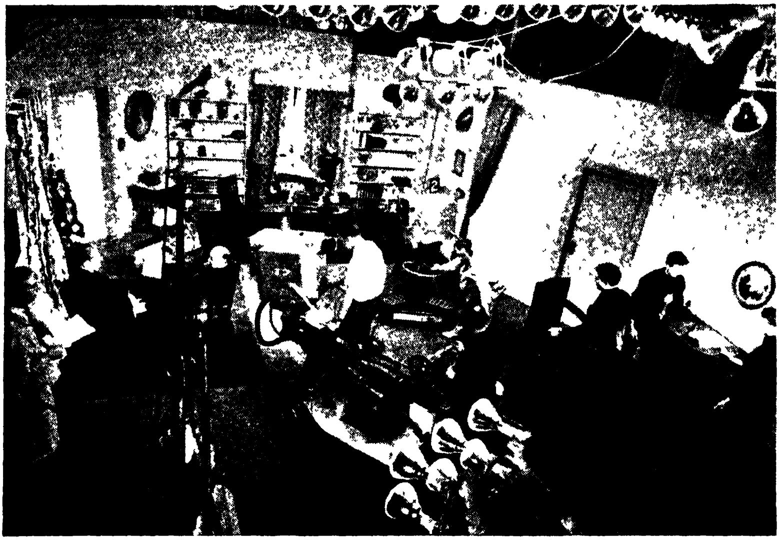


FIG. 83.—Back in Holmes' study (left) showing Holmes and Dr. Watson discussing Holmes' visit with Inspector Lestrade. On right, Lestrade's office being "struck" to make ready for Nathan Garrideb's cellar scene coming up.

WATSON

Do you mind, Mrs. Hudson?

MRS. HUDSON

Oh, Dr. Watson.

HOLMES

Entering door center
Oh, doctor, good afternoon. Just in time for luncheon. How about it, Mrs. Hudson?

MRS. HUDSON

I'll have it ready in a jiffy, sir. (*Exits*)

WATSON

Well?

HOLMES

This is a more serious matter than I had expected, Watson. (*Sits up right near window*)

WATSON

Then I'll see it through to the finish with you.

HOLMES

I expected that, but there is danger, and you should know it. Sit down. (*Watson sits facing him*) This morning I paid a visit to Inspector Lestrade of Scotland Yard and learned that our friend Mr. John Garrideb is pictured in the Rogues' Gallery as Killer Evans. SWITCH TO #2 ON HOLMES

WATSON

#1 in for close-up over Watson's shoulder

But what's his game?

HOLMES

It begins to define itself. From Scotland Yard I paid a visit to Holloway and Steele, Mr. Nathan Garrideb's agents.

WATSON

Why on earth did you go there?

HOLMES

Another elemental step in the problem, Watson. They confirmed our client's statement that he had occupied his present quarters for the past five years. It was unlet for a year before that. The previous tenant was a gentlemen named Waldron who was well remembered at the office. He had suddenly vanished and nothing more was heard of him. He was a tall bearded man with very dark features. Now our friend, John Garrideb alias Killer Evans, shot a man named Prescott, and Prescott was a tall dark man with a beard. As a working hypothesis I think we may take it that Prescott, an American criminal, used to live in the very room which our innocent friend now devotes to his museum. So at last we get a link. SWITCH TO #1 *#2 in close on Holmes* SWITCH TO #2 *#1 back for their rise* SWITCH TO #1

WATSON

And the next link?

HOLMES

Well, we must go and look for that. (*Rises. Takes revolver from table drawer which he hands to Watson*) *#2 on Mrs. Saunders at table center*

WATSON

What's this for?

FIG. 84.—Further progress in "striking" Lestrade's office and making ready for next scenes. Notice Nathan's study is again complete. All of this scene shifting is done quietly while show is in progress.

HOLMES

You may need it. I have an old favorite with me. If our wild west friend tries to live up to his nickname we must be ready for him. We'll have luncheon and perhaps a short siesta, and then, Watson, I think it will be time for our Ryder Street adventure.

(FADE SCENE)

SCENE VIII

FADE IN FAIRLY CLOSE SHOT OF MRS. SAUNDERS. SHE IS OBVIOUSLY ANXIOUS TO GET AWAY. SHE HAS HAT AND COAT ON. SHE LOOKS THROUGH MICROSCOPE—SNIFFS DISDAINFULLY—CROSSES UP AND LOOKS OUT WINDOW

SWITCH TO #2 ON MRS. SAUNDERS

#1 on door left

MRS. SAUNDERS

So there's the things he spends all his time looking at.

DISTANT CLOCK STRIKES FOUR

CLOCK

Four o'clock and he ain't here yet.

DOOR BELL RINGS

MRS. SAUNDERS

She crosses to door and opens it — SWITCH TO #1 ON DOOR

If you'd been a bit later, sir, you'd have missed me altogether as I'm just this minute through for the day. — *#2 holds*

HOLMES — SWITCH TO #2

Yes, Mr. Garrideb said you left at four o'clock.

MRS. SAUNDERS

If you'll just close the door when you leave, sir, it has a spring lock — *#1 pulls back to full shot of room*

HOLMES

I'll be sure to do that, Mrs. Saunders. — SWITCH TO #1

MRS. SAUNDERS

Well then, good day to you, sir. (*She exits closing door*)

WATSON

Now what's the plan?

HOLMES

Moving about the room

I'm definitely certain, Watson, that our American friend was determined to get Mr. Garrideb out of this room, and as the collector never left it, it took some deliberate planning to accomplish it. — *#2 on Holmes*

WATSON

But what did he want?

HOLMES — SWITCH TO #2 ON HOLMES—PAN WITH HIM

That's what we're here to find out. The whole of this Garrideb invention was devised for that one reason. There is a certain devilish ingenuity about it. Even if the queer name of the tenant did give him an opening which he could hardly have expected, he wove his plan with remarkable cunning. Has Mrs. Saunders left the house? — *#1 holds* — SWITCH TO #1

FIG. 85.—Behind the set, showing secret door being slid back, and John Garrideb, alias Killer Evans, feigning to descend to cellar with candle.

WATSON

At window
Yes, she just went down the street.

HOLMES

Good. Whatever the reason was for him to want to get our client out of this room, I am convinced it had nothing to do with our friend Nathan Garrideb.

WATSON

You mean it is something connected with the man he murdered, the man who used to live here?

HOLMES

Yes, a man who may have been his confederate in crime. There is some guilty secret in this room. *#2 back for John at door*

WATSON

But this collector may have something in his collection more valuable than he knows. #1 PANS WITH HOLMES AND WATSON TO POSITION TO SHOW THEM AND CABINET DOOR.

HOLMES

No, Watson, I believe that the fact that Roger Prescott lived here points to some deeper reason. (*A key is heard in the door. In whisper*) Quick, Watson, behind this curtain. (*They cross down behind curtain extreme left. They crouch behind curtain down left as John enters door left. He closes door softly, looks around room, and removes overcoat. He feels over wall up left for secret button. Finds it—cupboard up left center swings open. John looks down. Goes to center table—strikes match and lights stub of candle. He exits behind cupboard. Holmes and Watson with drawn revolvers come out from behind curtain and creep slowly toward open door left center and Holmes looks down. Shot of cellar. John is seen descending ship's ladder with light entirely from above. Halfway down John suddenly turns as*

SWITCH TO #2 ON JOHN

#1 holds

SWITCH TO #1 ON JOHN, HOLMES WATSON

#2 holds

SWITCH TO #2 ON JOHN

#1 holds

SWITCH TO #1 ON HOLMES AND WATSON

Ready #2 on cellar

SWITCH #2

HOLMES

Out of picture

Where are you going, Mr. Garrideb? (*With drawn revolver*) Keep your hands up, John Garrideb, alias James Winter, alias Killer Evans. We seem to have you trapped in your lair. *#1 on Holmes*

SWITCH TO #1 ON HOLMES

JOHN

#1 DOLLY BACK

Coming up from behind trap door with his hands in the air

Well, I guess you have been one too many for me, Mr. Holmes. You saw through my game, I suppose, and played me for a sucker from the start. Well, sir, I hand it to you; you've beaten me. *#2 in close on Holmes*

FIG. 86.—As seen on the receiver screen. Holmes speaking, " . . . if you had killed Watson, you wouldn't have gotten out of this room alive." Watson is holding his seared arm, as Killer Evans nurses his bumped head.

HOLMES

Search him, Watson. (*Turning to open door. Watson takes candle from John. As Watson turns away, John draws revolver from breast and fires twice. Watson cries out in pain and falls. Holmes strikes John on head with revolver. John crumples in chair. Holmes takes John's revolver from him and turns to Watson*)

SWITCH TO #2 ON JOHN
#1 on all three
SWITCH TO #1
#2 on Watson
READY #3

HOLMES

You're not hurt, Watson, for God's sake say you're not hurt.

SWITCH TO #2 ON WATSON

WATSON

It's nothing, Holmes, a mere scratch. (*He sits in chair right. Raises coat sleeve*) Only seared the flesh.

#1 holds

HOLMES

Examining wound

Yes, it's quite superficial which is particularly fortunate for you, Evans, for if you had killed Watson, you

wouldn't have gotten out of this room alive. (*Crossing up stage. Looking down trap door*) Let's see what's in the cellar. Watson, look. (*Holmes covering Evans with revolver looks down through trap with Watson*) A printing press—a counterfeiter's outfit.

SWITCH TO #1

SWITCH TO #3
LEICA SLIDE

JOHN

#1 *holds*

Yes, the greatest counterfeiter London ever saw. That's Prescott's machine, and those bundles on the table are two thousand of Prescott's notes worth a hundred each and fit to pass anywhere. Help yourselves, gentlemen. Call it a deal and let me beat it.

SWITCH TO #1 ON THE THREE MEN

HOLMES

#2 *on John close*

Laughing
We don't do things like that, Mr. Evans. There is no bolthole in this country. You shot this man, Prescott, did you not?

JOHN

Sitting
Yes, sir, and got five years for it. Five years—when I should have had a medal the size of a soup plate. No living man could tell a Prescott from a Bank of England, and if I hadn't put him out, he would have flooded London with them. I was the only man in the world who knew where he made them. Do you wonder that I wanted to get to the place? Do you wonder that when I found this crazy book of a bug-hunter with the queer name squatting right on the top of it and never quitting his room, I had to do the best I could to get him out? It would have been easier if I had put him away, but I'm a soft-hearted guy, Mr. Holmes, and I can't begin shooting unless the other man has a gun. But say, what have I done wrong, anyhow? I haven't used this plant. I didn't hurt the old stiff. Where do you get me?

SWITCH TO #2 ON JOHN

#1 *in on John*

SWITCH TO #1 ON JOHN AND HOLMES

#2 *on Holmes close*

SWITCH TO #2 ON HOLMES CLOSE-UP

HOLMES

On John's left
Only for attempted murder, as far as I can see. But that's not our job. They take that up at the next stage.

#1 *holds*

(*Nathan bursts in door right*)

SWITCH TO #1 ON THREE MEN

Fig. 87.—The perplexed Nathan Garrideb returns from his wild-goose chase, to find the Garrideb story a hoax and that John Garrideb is really Killer Evans. Camera #1 (at left) taking the long shots. Camera #2 in position to take the various close-ups noted in the script.

Nathan	
Say, what are you all doing here? And Mr. Garrideb? There wasn't any Garrideb in Birmingham at all. You must have made a mistake.	BACK FOR DOOP *#2 pans to Nathan*
Holmes	
I think he did. Permit me to introduce you to Killer Evans.	SWITCH TO #2 ON NATHAN
Nathan	
Killer Evans. Then he ain't a Garrideb?	
Holmes	
No—he's not a Garrideb.	
Nathan	
And there ain't no five million dollars?	#2 FOLLOWS NATHAN

FIG. 88.—The end. The villain, Killer Evans, is "covered" while waiting for Scotland Yard. Notice the shoulder holster on the Killer. This is a photo of the scene as seen on television receiver.

HOLMES

Yes, there's five million dollars all right. Downstairs in your cellar.

#1 dollies in for, close-up of Holmes' face

NATHAN

Downstairs?

HOLMES

But it's all counterfeit.

NATHAN

Counterfeit? Why—why—(*to John*) Why, you crook, you.

SWITCH TO #1 CLOSE-UP ON HOLMES

HOLMES

Yes, Mr. Garrideb, I'm afraid he is. Watson, give Scotland Yard a call. It won't be entirely unexpected.

FADE OUT #1

MUSIC IN

(FADE PICTURE)

APPENDIX II

RULES OF THE FEDERAL COMMUNICATIONS COMMISSION GOVERNING TELEVISION BROADCAST STATIONS

June 18, 1940

At several places in the text, notably in the chapter beginning on page 163, references are made to rules and regulations for television forthcoming from the Federal Communications Commission. These rules and regulations were issued after the text went to press and are reprinted below:

Sec. 4.71. *Defined.* The term "television broadcast station" means a station licensed for the transmission of transient visual images of moving or fixed objects for simultaneous reception and reproduction by the general public. The transmission of synchronized sound (aural broadcast) is considered an essential phase of television broadcast and one license will authorize both visual and aural broadcast as herein set forth.

Sec. 4.72. *Purpose.* A license for a television broadcast station will be issued for the purpose of carrying on research, which must include engineering experimentation tending to develop uniform transmission standards of acceptable technical quality, and which may include equipment tests, training of technical personnel, and experimental programs.

Sec. 4.73. *Licensing requirements, necessary showing.* A license for a television broadcast station will be issued only after a satisfactory showing has been made in regard to the following:

1. That the applicant has a definite program of research and experimentation in the technical phases of television broadcasting, which indicates reasonable promise of substantial contributions to the developments of the television art.
2. That upon the authorization of the proposed station the applicant can and will proceed immediately with its program of research.
3. That the transmission of signals by radio is essential to the proposed program of research and experimentation.
4. That the program of research and experimentation will be conducted by qualified personnel.

5. That the applicant is legally, financially, technically, and otherwise qualified to carry forward the program.
6. That public interest, convenience or necessity will be served through the operation of the proposed station.

Sec. 4.74. *Charges.* No charges either direct or indirect shall be made by the licensee of a television station for the production or transmission of either aural or visual programs transmitted by such station.

Sec. 4.75. *Announcements.*

(*a*) Station identification.—A licensee of a television broadcast station shall make station identification announcement (call letters and location) at the beginning and ending of each time of operation and during operation (other than purely test operation) on the hour and half hour as provided below:

1. Such identification announcement during operation need not be made when to make such announcement would interrupt a single consecutive speech, play, religious service, symphony concert, or operatic production of longer duration than 30 minutes. In such cases the identification announcement shall be made at the first interruption of the entertainment continuity and at the conclusion of such program.
2. In case of variety-show programs, baseball-game broadcasts, or similar program of longer duration than 30 minutes, the identification announcement shall be made within 5 minutes of the hour and half hour.
3. In case of all other programs (except as provided in paragraphs (1) and (2) of this section) the identification announcement shall be made within 2 minutes of the hour and half hour.
4. In making the identification announcement, the call letters shall be given only on the channel of the station identified thereby.

(*b*) At the time station identification announcements are made, there shall be added the following:

> "This is a special television broadcast made by authority of the Federal Communications Commission for experimental purposes."

Sec. 4.76. *Operating requirements.*

(*a*) Each licensee of a television broadcast station shall diligently prosecute its program of research from the time its station is authorized.

(*b*) Each licensee of a television station will from time to time make such changes in its operations as may be directed by the Commission for the purpose of promoting experimentation and improvement in the art of television broadcasting.

Sec. 4.77. *Frequency assignment.*

(*a*) The following groups of channels are allocated for assignment to television broadcast stations licensed experimentally:

Group A		Group B		Group C
Channel 1	50,000– 56,000 kc.	Channel 8	162,000–168,000 kc.	Any 6,000-kc. band above 300,000 kc. excluding band 400,000 to 401,000 kc.
2	60,000– 66,000 kc.	9	180,000–186,000 kc.	
3	66,000– 72,000 kc.	10	186,000–192,000 kc.	
4	78,000– 84,000 kc.	11	204,000–210,000 kc.	
5	84,000– 90,000 kc.	12	210,000–216,000 kc.	
6	96,000–102,000 kc.	13	234,000–240,000 kc.	
7	102,000–108,000 kc.	14	240,000–246,000 kc.	
		15	258,000–264,000 kc.	
		16	264,000–270,000 kc.	
		17	282,000–288,000 kc.	
		18	288,000–294,000 kc.	

(*b*) No television broadcast station will be authorized to use more than one channel in Group A except for good cause shown. Both aural and visual carriers with side bands for modulation are authorized but no emission shall result outside the authorized channel.

(*c*) No person (including all persons under common control) shall, directly or indirectly, own, operate or control more than three television stations on channels in Group A, and no such person shall, directly or indirectly, own, operate or control on channels in Group A more than one television station which would serve in whole or substantial part the same service area as another station operated or controlled by such person. This paragraph (*c*) shall not apply to stations which do not transmit programs for public reception.

(*d*) Channels in Groups B and C may be assigned to television stations to serve auxiliary purposes such as television relay stations. No mobile or portable station will be licensed for the purpose of transmitting television programs to the public directly.

Sec. 4.78. *Power.* The operating power of a television station shall be adequate for but not in excess of that necessary to carry forward the program of research and in no case in excess of the power specified in its license.

Sec. 4.79. *Reports.*

(*a*) A report shall be filed with each application for renewal of station license which shall include a statement of each of the following:

1. Number of hours operated.
2. Full data on research and experimentation conducted including the type of transmitting and studio equipment used and their mode of operation.
3. Data on expense of operation during the period covered.
4. Power employed, field intensity measurements and visual and aural observations and the types of instruments and receivers

utilized to determine the service area of station and the efficiency of respective types of transmissions.

5. Estimated degree of public participation in reception, and the results of public observation as to the efficiency of types of transmission.
6. Conclusions, tentative and final.
7. Program for further developments in television broadcasting.
8. All developments and major changes in equipment.
9. Any other pertinent developments.

(*b*) Special or progress reports shall be submitted from time to time as the Commission shall direct.

INDEX